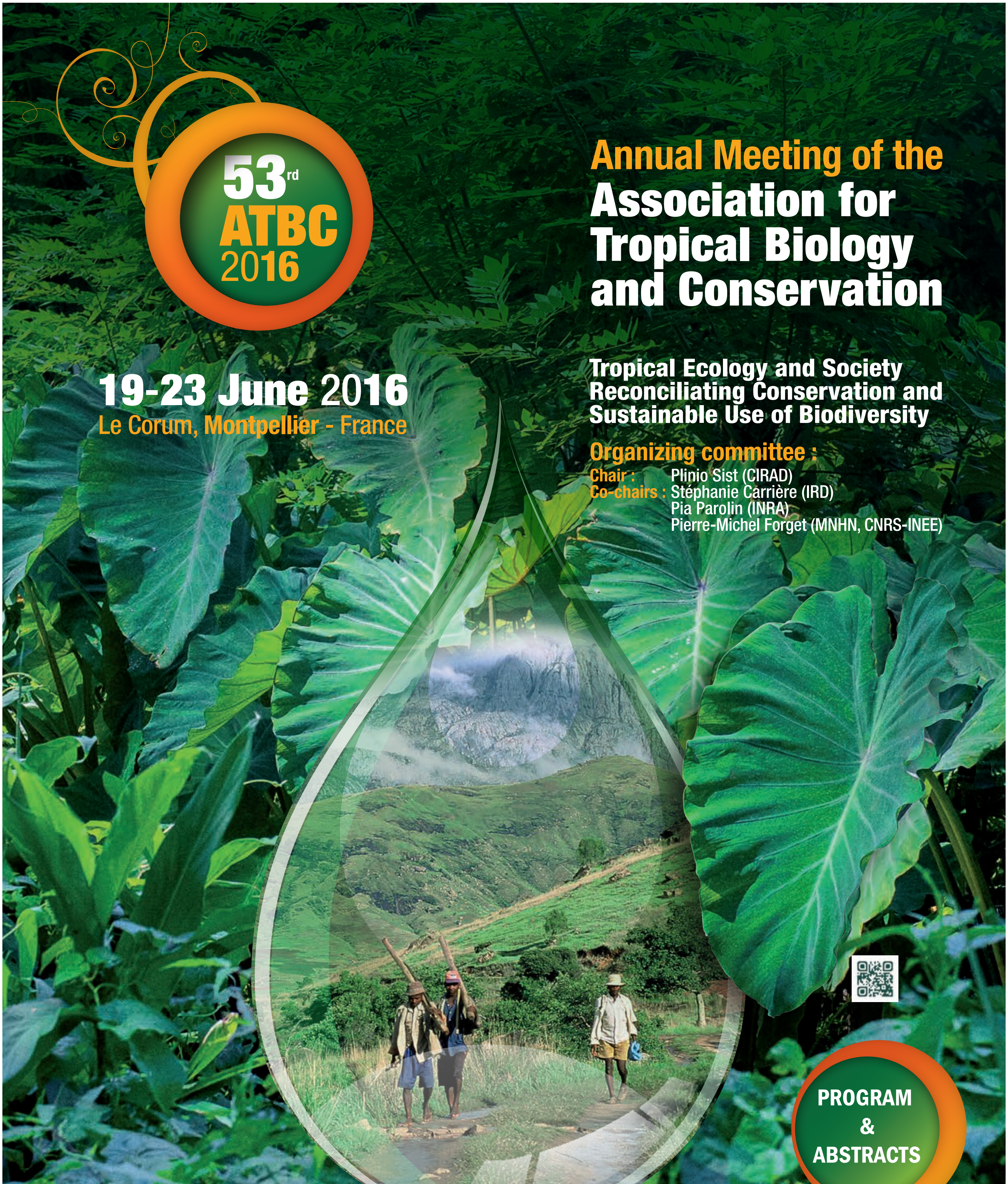

53rd ATBC 2016

Annual Meeting of the Association for Tropical Biology and Conservation

19-23 June 2016

Le Corum, Montpellier - France

Tropical Ecology and Society Reconciliating Conservation and Sustainable Use of Biodiversity

Organizing committee :

Chair : Plinio Sist (CIRAD)

Co-chairs : Stéphanie Carrière (IRD)
Pia Parolin (INRA)
Pierre-Michel Forget (MNHN, CNRS-INEE)

PROGRAM & ABSTRACTS

www.atbc2016.org

Association for Tropical Biology and Conservation

cirad

IRD Institut de recherche pour le développement

INRA

Muséum National d'Histoire Naturelle

cnrs

CIFOR

CONGRESS OFFICE

HOPSCOTCH CONGRÈS

23/25, rue Notre-Dame des Victoires
75002 Paris | France
www.hopscotchcongres.com

Around the world, conserving forests is always news.
Livelihoods | wildlife | smallholders | tropical ecology | oil palm
water | tenure | deforestation | landscapes | sustainability
CIFOR's global, multidisciplinary approach to forests aims to improve human well-being, protect the environment and increase equity, and its scientists continue to work on issues related to tropical forests and sustainability.
To learn more about CIFOR's sessions at the 53rd Annual Meeting of the Association for Tropical Biology and Conservation, please visit our booth or go to cifor.org/cifor-at-atbc-2016.
CIFOR
Center for International Forestry Research
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Photo courtesy of CIFOR

Table of contents

Welcome

We welcome all of you to the first ATBC meeting held in France. We hope you have fruitful interactions with colleagues, old friends, and new collaborators and mentors amidst the beautiful surroundings.

Founded in 1963, the Association for Tropical Biology and Conservation (ATBC) is a membership corporation, international in scope, membership, and objectives, functioning as an international body to foster scientific understanding and conservation of tropical ecosystems by supporting research, collaboration, capacity building, and communication among tropical biologists and conservationists. The ATBC, currently with members from over 65 countries, composes a broad community of tropical biology professionals and provides outlets for research dissemination, educational and funding opportunities, particularly for early career scientists working across the tropics. As a diverse community of science professionals, the ATBC provides a credible, collective, and authoritative vision of tropical biology and conservation issues that underpin public policy and management action. Our journal, Biotropica, is the leading international journal on tropical biology, and publishes six issues per year on-line.

Starting with the Asia-Pacific and Student and Early Career Scientist Chapters, new regional and thematic chapters are being formed to provide more outlets for collaboration, communication, and regional networking. The ATBC also offers a Mentoring program and Capacity Building activities at annual meetings. The Conservation Chapter works actively to focus on important issues where ATBC resolutions and declarations can have an impact on decision making and mobilizing conservation actions around the tropics. We offer many ways to become involved.

ATBC provides tiered membership options for students and regular members regardless of economic status, and provides a limited number of travel grants to annual meetings. We aim to be supportive, inclusive, participatory, transparent, and multidisciplinary in all of our activities and events.

Please visit our website for more information • **http://tropicalbiology.org**

Greetings and welcome to Montpellier and to the first meeting in France, and the third meeting in Europe of the Association for Tropical Biology and Conservation! Our 53rd Annual Meeting focuses on reconciling conservation with the sustainable use of biodiversity, and follows on the momentum generated by the COP21 in Paris. We are fueled by the power that research collaboration and communication among scientists can unleash for the betterment of the environment, biodiversity, and society. This meeting represents a partnership among many organizations (International Union of Forest Research Organizations, Center for International Forest Research, British Ecological Society Tropical Ecology Group, Society for Tropical Ecology, Société Française d'Ecologie) and several host institutions (CIRAD, IRD, INRA, CNRS, and Muséum National d'Histoire Naturelle). We thank them and all of our sponsors for their support and for making this exciting and important meeting possible. Together we can forge new paths that unite conservation and sustainable development in the tropics. Let this meeting be a new beginning for all of us.

Pr. Robin CHAZDON
ATBC Executive Director

Pr. Kaoru KITAJIMA
ATBC 2016 President

Welcome

Welcome to the 53rd ATBC 2016 annual meeting held in Montpellier, France. The location of the conference in a temperate country to debate about tropical ecosystems biodiversity can be at first glance surprising, but Montpellier gathers one of the most important French research institutions involved in natural resources management issues in tropical regions. Having this 53rd ATBC meeting here is therefore a recognition of the work of these institutions to improve biological conservation in tropical countries. We are grateful to Montpellier region and its academic institutions for supporting the organization of the ATBC Annual Meeting. The conference theme is "Tropical Ecology and Society: Reconciling Conservation and Sustainable Use of Biodiversity", a theme that is particularly relevant for tropical ecosystems which are still under constant pressure by conversion to agriculture and pastures, are in most cases unsustainably exploited for their goods and faced therefore high degradation pressure as well. Moreover, six months after the Paris declaration of the COP 21, the challenges to fight climate change still remain very present in our minds. In this context, we all know that conservation and sustainable use of the biodiversity of tropical ecosystems will play a major role in any action taken towards climate change mitigation and adaptation. In a world where human population of 9 billions people is expected for 2050, tropical biodiversity will have to be maintained in human-modified and sometimes novel environments. Reconciling conservation and sustainable use of biodiversity in the tropics is therefore a major challenge for the present and the future of tropical ecosystems. The 53rd ATBC Annual Meeting is a great opportunity for tropical biologists from many different disciplines and regions attending to exchange ideas, concepts and approaches, as well as to elaborate and promote innovations for the conservation of tropical ecosystems in the decades to come.

We hope that you will all enjoy the program of this conference which includes more than 70 symposia and free sessions. We have no doubt that you will meet old friends and make new ones, and will have exciting discussions. We are sure that you will also enjoy Montpellier and its beautiful countryside.

Finally, we would like to take this opportunity to thank all the colleagues of the organizing committee and everyone who has worked with us to make this meeting possible, and for sure a great success.

Dr. Plinio SIST
Program Chair

Dr. Stéphanie CARRIÈRE
Program Co-Chair

Dr. Pia PAROLIN
Program Co-Chair

Pr. Pierre-Michel FORGET
Program Co-Chair

ATBC 2016 ORGANIZATION

■ ORGANIZING COMMITTEE

CHAIR

Plinio SIST (CIRAD)

Plinio Sist is the director of the Research Unit Forêts et Sociétés at Cirad and the coordinator of the unit "Tropical and subtropical silviculture » of Division 1 at IUFRO. He is a tropical forest ecologist with more than 25 year experience in South America (Brazil, Ecuador, Peru, Costa-Rica) and South East Asia (Indonesia, Malaysia). His main interest is to understand the impact of forest harvesting on the ecology of tropical forests in order to recommend sustainable forest management practices.

CO-CHAIRS

Stéphanie CARRIÈRE (IRD)

Stéphanie M. Carrière is co-responsible for the multidisciplinary research team 1: "Biodiversity and society" of the Research Unit GRED (Governance, Risk, environment & Development) at IRD. She is working as a tropical ecologist and ethnobiologist mainly in central Africa and Madagascar tropical rain forests for about 20 years. Her particular interest is to address ecological dynamics induced by human activities especially in tropical agroecosystems but also to understand the potential role of local ecological knowledge and practices on biodiversity conservation.

Pia PAROLIN (INRA)

Pia Parolin is an ecologist and botanist at the Agronomy Research Institute (INRA) in Nice/Sophia Antipolis, France, and at the Dept. of Biodiversity of Plants / University of Hamburg, Germany. She is the Vice-President of the Society for Tropical Ecology (gtö) and the Chair of the Conservation Committee of the Association for Tropical Biology and Conservation (ATBC). She studies floodplain ecology in the Amazon and the Pantanal in Brazil. She is part of the founding group of ATBC Europe and hopes to contribute, with this European ATBC meeting in Montpellier, to improve the networking between European tropical ecologists.

Pierre-Michel FORGET (MNHN)

Pierre-Michel Forget is professor of tropical ecology of the Muséum National d'Histoire naturelle (MNHN), deputy director of the research unit MECADEVof the Institut Ecologie et Environnement (INEE). He is past-president (2008) of the Association for Tropical Biology and Conservation (ATBC), and current vice-president of the Society for Tropical Ecology. He had (co-)chaired ATBC2008 and ATBC2012 meetings, and the symposia on frugivores and seed dispersal (FSD) in 2010 and 2015. His research is about the animal-plant relationships in tropical rainforests, Carapa tree diversity, the sustainable use and conservation of non-timber forest products, and the impact of anthropogenic activities on biodiversity and tropical ecosystem health.

ATBC 2016 ORGANIZATION

■ ATBC

The 53rd Annual Meeting of the Association for Tropical Biology and Conservation is organized by

Association for Tropical Biology and Conservation

Association of Tropical Biology and Conservation

The Association for Tropical Biology and Conservation (ATBC) is an international professional society formed in 1962 to promote awareness, research, education, and communication in all aspects of tropical biology and conservation. ATBC publishes a scholarly journal, Biotropica, hosts a website, and organizes an annual meeting each year. The activities of ATBC and its members promote the understanding, education, and conservation of tropical biology diversity for posterity, for its intrinsic worth and for aesthetic and tangible values to humanity.

Robin CHAZDON, Executive Director
Department of Ecology & Evolutionary Biology Unit 3043
University of Connecticut
Storrs CT 06269-3043 USA
Email: rchazdon@gmail.com
www.eeb.uconn.edu/people/chazdon
www.tropicalbio.org

■ SCIENTIFIC COMMITTEE

CHAIRS OF SYMPOSIA

Alexander SHENKIN, University of Oxford, UK
Alice C. HUGHES, Xishuangbanna Tropical Botanic Garden, China
Amy DUCHELLE, Center for International Forestry Research, Indonesia
Amy E ZANNE, George Washington University, USA
Caroline DRACXLER, Muséum National d'Histoire Naturelle, France
Caroline LEHMANN, School of GeoSciences, University of Edinburgh, UK
Charles DOUMENGE, CIRAD, France
Christelle GONMADJE, University of Yaounde I, Department of Plant Biology, Cameroon
Claire TITO DE MORAIS, ETH Zurich, Switzerland
Daniel CORNELIS, CIRAD, France
Eileen HELMER, USDA Forest Service, USA
Elise BUISSON, Université d'Avignon, IMBE, CNRS, IRD, AMU, France
Emile FONTY, Université de Liège - Gembloux AgroBio Tech - Gestion des Ressources Forestières - Foresterie Tropicale, Belgium
Erin KUPREWICZ, Institute of Ecology & Smithsonian Institution, Mexico
Ervan RUTISHAUSER, CarboForExpert Switzerland
François MUNOZ, French Institute of Pondicherry, Inde
Frank CEZILLY, Université de Bourgogne, France
Guillermo GOLDSTEIN, Universidad de Buenos Aires, Argentina
Hans BEECKMAN, Gembloux Agro-Bio Tech & University of Liège, Belgium
Inara LEAL, Universidade Federal de Pernambuco, Brazil
Irene MENDOZA, Universidade Estadual Paulista, Brazil
Jaboury GHAZOUL, ETH Zurich, Switzerland
Jefferson HALL, Smithsonian Tropical Research Institute, Panama
Jenny ZAMBRANO, SESYNC, USA
John TERBORGH, Duke University, Durham, USA

ATBC 2016 Organization

Joice FERREIRA, Embrapa Amazônia Oriental, Brazil
Jose (Joe) Manuel. V FRAGOSO, California Academy of Sciences, USA
Jozsef GEML, Naturalis Biodiversity Center, Netherlands
Krista McGUIRE, Barnard College, Columbia University, USA
Kyle DEXTER, University of Edinburgh, UK
Liza COMITA, Yale University, USA
Louise ASHTON, Natural History Museum, UK
Lucia LOHMANN, Universidade de São Paulo, Brazil
Magali PROFFIT, CEFE-CNRS, France
Maria GEI, University of Minnesota, USA
Marie Claude HUYNEN, University of Liege, Belgium
Marie-Pierre LEDRU, IRD, France
Mark HIRONS, University of Oxford and University of Reading, UK
Marney ISAAC, University of Toronto, Canada
Mélanie ROY, Université Paul Sabatier, Toulouse
Nicole GROSS-CAMP, University College London, UK
Onja RAZAFINDRATSIMA, Rice University (77005 Houston, Texas - USA)
Orou GAOUE, University of Hawaii at Manoa, USA
Patricia BALVANERA, Institute of Ecosystems and Sustainability Research, UNAM
Patrick JANSEN, Smithsonian Tropical Research Institute, Netherlands
Regis CEREGHINO, Université de Toulouse, France
Ricardo CAMPOS, Department of Earth, Ocean & Ecological Sciences, University of Liverpool, England
Rosie TREVELYAN, Tropical Biology Association, UK
Rumsais BLATRIX, CEFE/CNRS, France
Sam MOORE, University of Oxford, UK
Sophie CALME, Université de Sherbrooke, Canada
Stephan A. PIETSCH, International Institute of Applied Systems Analysis, Austria
Sue PALMINTERI, RESOLV, USA
Sylvie GOURLET-FLEURY, CIRAD, France
Thibaud DECAENS, Université de Montpellier, France
Tuyeni H. MWAMPAMBA, National Autonomous University of Mexico, Mexico
Valery GOND, CIRAD, France

■ LOCAL ORGANIZING COMMITTEE

Pierre-Michel FORGET
ATBC2008 Association, Loi 1901.
http://www.carapa.org/fr/Colloques/ATBC2008%20Association.htm

Lionel CAVICCHIOLI (Service Communication, Attaché de Presse)
Jean-François TRÉBUCHON (Bois & Forêt des Tropiques, Tenu du stand)
Frédérique CAUSSE (Service Communication)
Christiane JACQUET (Service Communication)

ATBC 2016 Organization

Nathalie FINOT, Bernard MOIZO (UMR GRED)
Catherine PLASSE, Corinne LAVAGNE et Régine ALIAGA
(Stad Editions IRD)

Doyle McKEY (Université Montpellier/CNRS CEFE)

Sabine SABATIER (LE CORUM)

Eric GUILBERT (UMR MECADEV)
Marc-André SELOSSE (UMR ISYEB)

■ OUR PROFESSIONAL CONGRESS ORGANIZER (PCO)

The Professional Congress Organizer (PCO) of the 53rd ATBC is **HOPSCOTCH CONGRES**

We are a creative agency specializing in the organization of professional meetings and congresses. We operate mainly in the health care sector, for scientific communities as well as professional institutions and federations. We are organized in 2 main strategic units: PCO (Professional Congress Organizer) and Health Care Events.

As a PCO, our mission is to assist our clients in the organization of their congress, the management of their association (Association Management Company) and in drawing up their bids for the organization of international congresses.

As partners of the health care professionals, we offer solutions in the organization of seminars, symposia and events as well as in the regulatory management of the professional relationships.
Our mission: deliver consulting services, sector expertise and a rigorous process in designing your community's key event.

Sponsoring

INSTITUTIONS & FINANCIAL SUPPORT

We are grateful for all institutions that offered financial support, donations or contributed to the organization of the meeting.

ATBC

CARIBAEA INITIATIVE

CIRAD

CNRS - INSTITUT ECOLOGIE ET ENVIRONNEMENT

FRENCH EMBASSY IN INDIA

FRENCH EMBASSY IN MALAYSIA

FRENCH EMBASSY IN THE UNITED STATES

Sponsoring

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IRD

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NEW PHYTOLOGIST

OFFICE DU TOURISME

OXFORD UNIVERSITY PRESS

RÉGION LANGUEDOC ROUSSILLON MIDI PYRÉNÉES

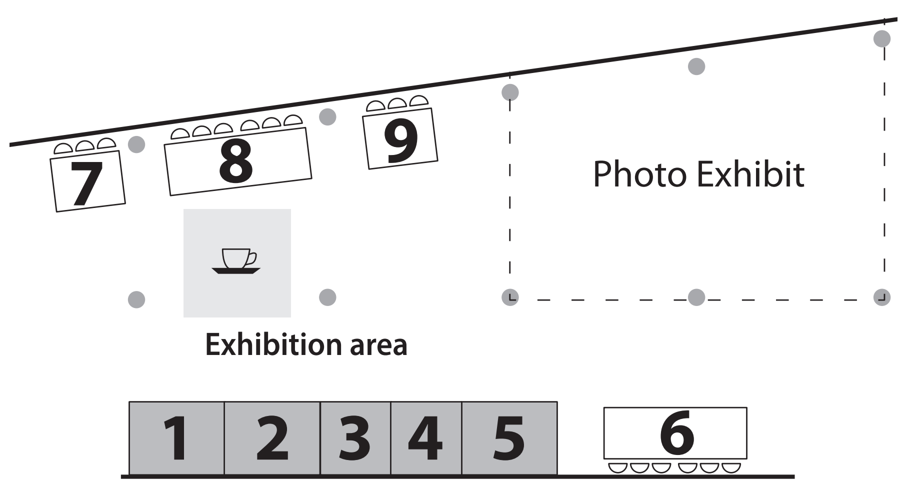
THE RUFFORD FOUNDATION

SPONSORING

■ EXHIBITORS

Acknowledgements to our sponsors

	ATBC	Booth 8
	CIFOR	Booth 1
	CNRS INEE / MNHN / ECOTROP / CAFOTROP	Booth 4
	CIRAD	Booth 2
	IRD	Booth 7
	LABEX CEBA	Booth 5
	OFFICE DU TOURISME	Booth 6
	SOCIETY FOR TROPICAL ECOLOGY (GTOE17)	Booth 9
	SPRINGER	Booth 3



General information

■ ATBC MEMBERSHIP

Association for Tropical Biology and Conservation

As a member you will:

- **benefit preferential prices to register at the 53rd ATBC 2016**
- be allowed 10 free published pages in **BIOTROPICA** annually
- get access to member-only conference registration rates
- be elegible for presentation awards during annual meetings
- be elegible for travel grants to assist to annual meetings
- have a webpage for your field site promoted at tropicabio.org
- have your **BIOTROPICA** paper highlighted at our FaceBook page

For more information please visit Wiley or email cs-membership@wiley.com

■ ATBC SOCIAL NETWORKS

ATBC **https://twitter.com/tropicbiocon**
https://www.facebook.com/TropicalBiologyConservation

ATBC Europe Group
https://www.facebook.com/groups/806472452717639/

ATBC-SECSCI (Student and Early Career Scientist Chapter)
https://www.facebook.com/groups/1429717710644455/

ATBC Africa Chapter (creation in progress)
https://www.facebook.com/groups/1606854326244847/

ATBC2016
https://twitter.com/atbc2016
https://www.facebook.com/groups/1475460059380114/

GENERAL INFORMATION

■ SOCIAL PROGRAM

WELCOME COCKTAIL
WINE & CHEESE
Sunday 19 June
19:00 - 20:00
THE CORUM ROOF TOP - TBC

ATBC BANQUET
Thursday 23 June
19:00 - 00:00
CATERING AREA - LEVEL 3

Please note that, we will control your registration at the entrance.
PLEASE DO NOT FORGET YOUR BADGE !
There is your registration confirmation indicated on it.

■ INFORMATION FOR PARTICIPANTS

BADGES

Your name badge is entry to all sessions, the exhibition, events & all catering services*.
Please wear your name badge at all times.
only for full registration fees

CATERING

Our whole catering service is provided by Cabiron Traiteur

Full registration fees included:
- Welcome Cocktail
- Breaks
- Lunches
- ATBC Banquet

Please note that, we will control your registration at the entrance of the lunch room
PLEASE DO NOT FORGET YOUR BADGE !
There is your registration confirmation indicated on it.confirmation indicated on it.

Registration fees per day included only breaks

Breaks will be served each day in Poster Sessions Area (Level 1) and Exhibition Area (Level 2).
Lunches will be served each day in Esplanade (Level 3) from 12:00 to 13:30.

MESSAGES AND NOTICES

Messages and Notices can be posted on the Message and Notice Board positioned near the Welcome Desk (Level 1). Please regularly check the board on passing. Unfortunately, messages cannot be personally delivered by Conference staff.

GENERAL INFORMATION

EMERGENCY PROCEDURES AND FIRST AID

In the case of an emergency, please inform the ATBC safety staff by phone +33 (0)4 67 61 67 97 . Traveling and time zone differences can affect the body so feel free to stop in for medications, diagnosis, rest, minor injuries, or even to nurse for new mothers.

WIFI

Free wireless internet is available at no cost,
with a password in each conference rooms and areas.

SSID: ATBC2016
PASSWORD: 53rd_2016

INTENTION TO PHOTOGRAPH

Delegates and others are advised that photographs may be taken during the conference and reproduced for promotional purposes.

■ SERVICES DEDICATED TO ATTENDEES

WELCOME PACK

We are delighted to welcoming you in Montpelier during the 53rd ATBC 2016.
After your check-in at your arrival in the venue, go to our Welcome Desk (Level 1) to get your Welcome Pack including: Congress program, goodies …

CHILD CARE

The ATBC 2016 organizers are please to make available to our attendees Child Care in the venue. We have teamed up with Les Ateliers d'Arthur to provide child care for your children.
You have to drop your child at the child care room (level 0).

FIELD TRIP

Discover region of Montpellier with our fiel trips preferential prices!
More details on www.atbc2016.org

PUBLIC TRANSPORT PASS

ATBC 2016 organizers have negotiated special prices for public transport pass for their attendees.
Public transport pass are valided in whole Montpelier transport network.
- 3-day pass: 5 € TTC
Our pass will be on sale From Sunday 19 June to Tuesday 21 June at the Tourism Office Booth.

DISCOUNT SHOPPING

Enjoy shopping in Montpellier with 10% discount !
More details on the tourism office booth (level 2) and on www.atbc2016.org

AIRPORT AND TRAIN STATIONS WELCOME

Please note that, our staff will welcome you at your arrival in Montpelier Airport and/or Train station.

TAXIS

Our Montpellier Taxi partners are informed about your stay in Montpellier.
A list of taxis will be available at the Welcome Desk (Level 1).

General information

■ INFORMATION FOR AUTHORS

PREVIEW (JOFFRE 5, Level 1)

All speakers are requested to check-in their presentation to the ATBC technical team at least a half day prior to their presentation.
All presentations will be networked from the upload desk to the presentation rooms.
The presentation upload desk will be open each day from 8:00 to 19:30.

PLENARY SESSIONS

Keynote speakers are advised to prepare PowerPoint presentation with a time slot of 60 minutes with 5 minutes for couple of questions.

ORAL PRESENTATION

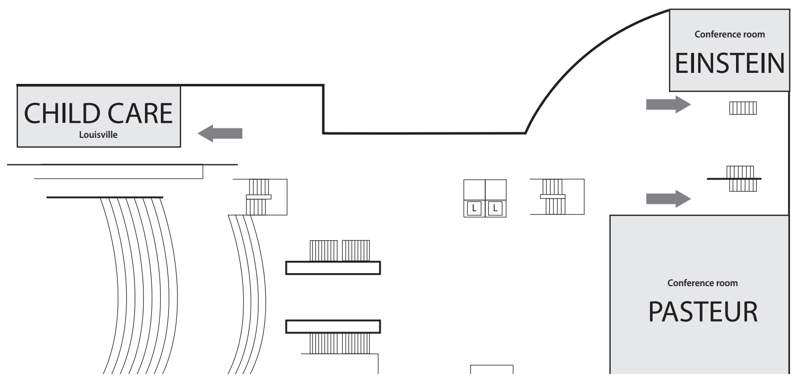
Participants are advised to prepare PowerPoint presentation with a time slot of 15 minutes, chich includes approximately 12 minutes for the presentation and 3 minutes for question and discussion.

POSTER PRESENTATION

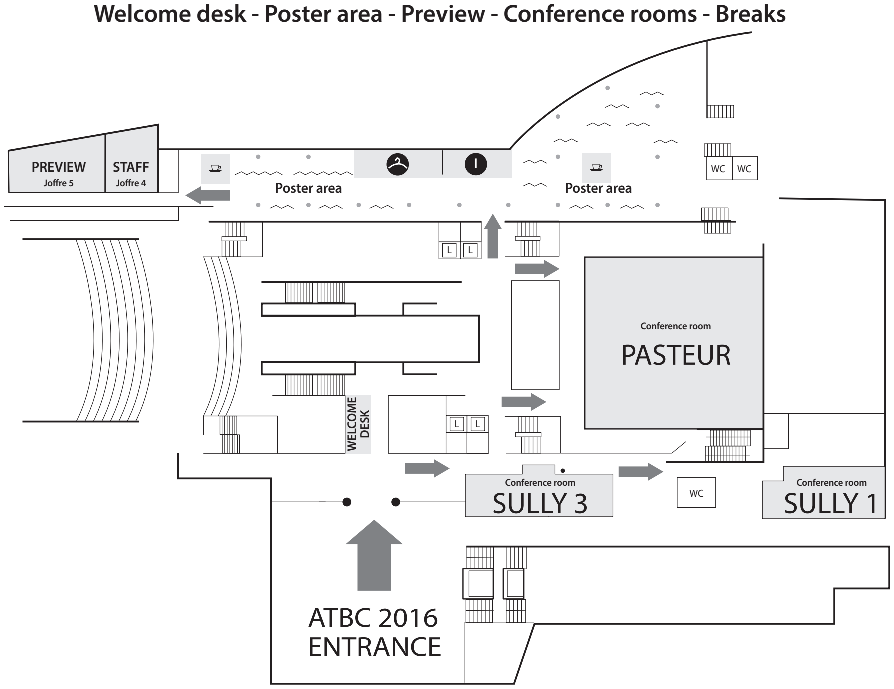
The size of Poster Board is 100 X 120 cm (Width x Height) size maximum.
Poster should then be 96 X 117 cm (Width x Height) max.
Facilities to hang your Poster will be available on your Poster Board.
Each selected author have to give a presentation of their poster during their dedicated poster session day.
The scientific committee advise each selected author to be present at each poster sessions during ATBC 2016.

■ VENUE MAP

LEVEL 0
Conference rooms - Child care



LEVEL 1
Welcome desk - Poster area - Preview - Conference rooms - Breaks

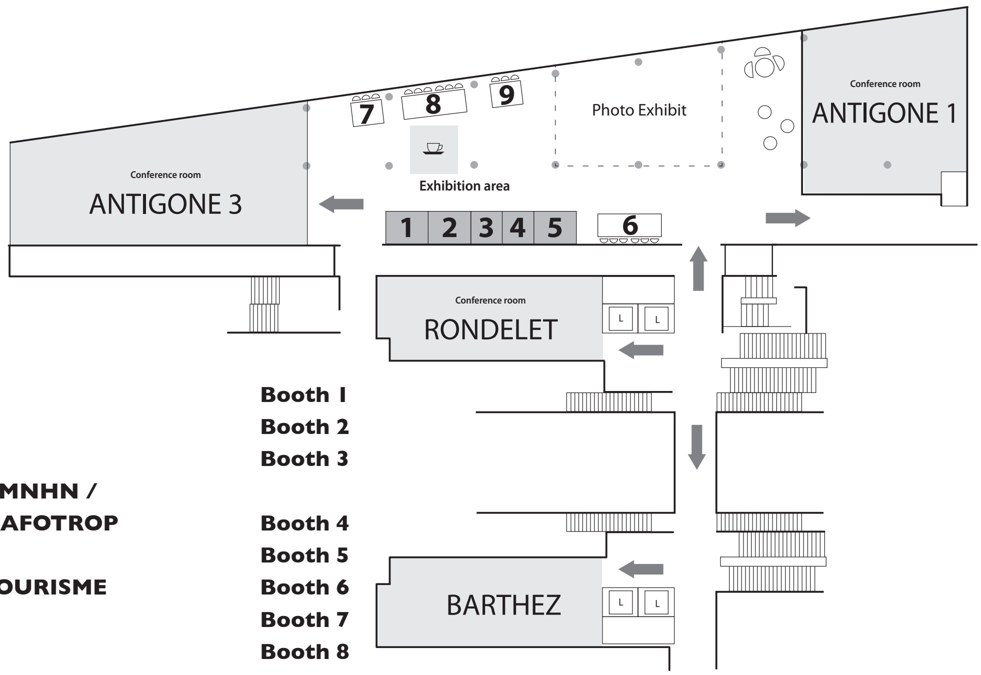


General information

■ VENUE MAP

LEVEL 2

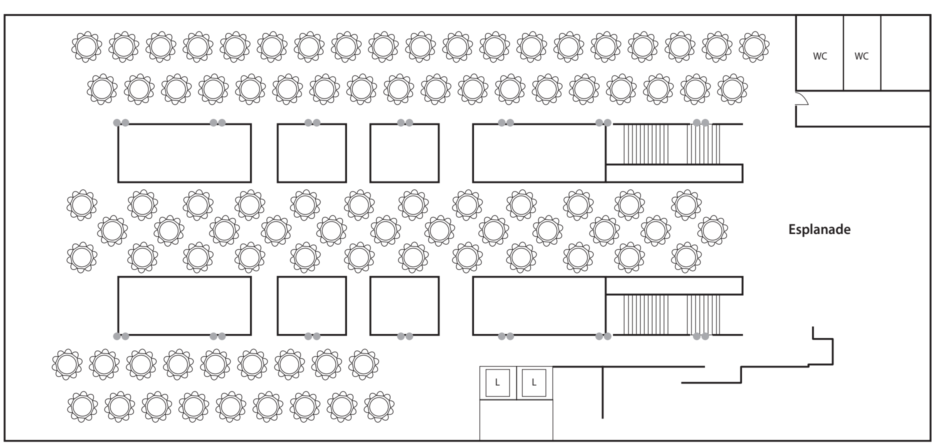
Exhibition area - Conference rooms - Networking zone - Breaks



CIFOR	**Booth 1**
CIRAD	**Booth 2**
SPRINGER	**Booth 3**
CNRS INEE / MNHN / ECOTROP / CAFOTROP	**Booth 4**
LABEX CEBA	**Booth 5**
OFFICE DU TOURISME	**Booth 6**
IRD	**Booth 7**
ATBC	**Booth 8**
SOCIETY FOR TROPICAL ECOLOGY (GTOE17)	**Booth 9**

LEVEL 3

Catering area



Highlights

■ OPENING CONFERENCE - H1

Sunday 19 June
18:00 - 19:00
Pasteur - Level 0 & 1

Please join us for our welcome ceremony, followed by welcome cocktail for every registered participant.

Plinio SIST / ATBC2016 Program Chair
Kaoru KITAJIMA / ATBC President
Region Representatives / (TBA)
Institutional Representatives / (TBA)

Welcome Cocktail (Sunday 19 June)

■ OPENING WELCOME - H2

Monday 20 June
9:00 - 9:30
Pasteur - Level 0 & 1

Please join us for the official opening of the meeting and the plenary lecture.

Official Opening / Robin CHAZDON/ ATBC Executive Director

Official Opening and Presentation / Plinio SIST / ATBC2016 Program Chair

Introduction of the Opening Plenary Lecturer
Kaoru KITAJIMA, Professor, Kyoto University and ATBC President
Women in tropical biology and consersation
Introduced by Pr. Robin CHAZDON, ATBC ED, Univ. Connecticut

■ ATBC TOWN HALL MEETING - H3

Monday 20 June
18:30 - 19:30
Pasteur - Level 0 & 1

Robin CHAZDON/ ATBC Executive Director
ATBC members are kindly invited to meet and discuss various topics such as Conservation, Biotropica, Chapters, Capacity Building Initiatives, etc. We will have break-out groups and it will be a great opportunity for members to learn more about what ATBC is doing and how they can get involved.

Highlights

■ GENDER COMMITTEE WORKSHOP - H4

Tuesday 21 June
18:30 - 19:30
Pasteur - Level 0 & 1
Keynote speaker: Dr Michael BALTER, Adjunct Professor of Journalism, New York University

Introduced by Dr. Krista McGuirre, Barnard College, Columbia University, USA

This year the Gender Committee of the ATBC will be leading a workshop on sexual harassment. The workshop will feature a talk by former Science writer Michael Balter who wrote the recent exposé on the sexual harassment case in anthropology at the American Museum of Natural History. Following the presentation, we will devise a plan to create a best practices document for the ATBC to prevent sexual misconduct and harassment, and to provide resources for reporting such incidences.

■ PHOTO CONFERENCE - H5

Wednesday 22 June
18:30 - 19:30
Pasteur - Level 0 & 1

Photo conference (Slide show) by Christian ZIEGLER, Wildlife-and conservation Photographer, Contributing photographer, National Geographic Magazine, sponsored by the Society for Tropical Ecology (Wednesday 22nd) - Pasteur.
Jungle Spirits - celebrating tropical biodiversity
Introduced by Dr. Daisy DENT, University of Stirling, UK

■ CLOSING CEREMONY - H6

Thursday 23 June
17:30 - 19:00
Pasteur - Level 0 & 1

Introduction/ Jaboury GHAZOUL / ATBC Past President

Best Presentation Awards/ Kyle HARMS and Julieta BENITEZ-MALVIDO /Chair Award Committee

Alwyn Gentry Award for Best Student Presentations
Alwyn Gentry's legacy to tropical biology was not limited to the phenomenal contributions he made to the study of diversity and conservation of tropical plants. He was a caring and supportive mentor to students from all over the Americas. In remembrance and recognition of the contributions of a singular scientist, colleague, mentor, and friend, the Association for Tropical Biology and Conservation presents the Alwyn Gentry Awards for the Best Student Oral and Best Student Poster Presentations each year at its Annual Meeting.

Highlights

Luis F. BACARDI Advances in Tropical Conservation Award
Each year the Association for Tropical Biology and Conservation recognizes outstanding research in tropical conservation through its Luis F. Bacardi Advances in Tropical Conservation Award. The award is given for the most outstanding oral presentation at the ATBC annual meeting focusing on tropical conservation, by a young scientist who is an ATBC member and who has completed his/her PhD no more than five years before the date of the presentation. This award is made possible with generous support from the Lubee Bat Conservancy.
Recognition of all meeting committee members, staff, and volunteers; and the official closing of scientific sessions.

Honorary Fellow Decoration / Robin CHAZDON / ATBC Executive Director

Launching of the Africa Chapter / Tuyeni Heita Mwampamba / Meeting Committee (ATBC2011)

Montpellier declaration / Pia PAROLIN / Conservation Committee & ATBC2016 Co-Chair

Acknowledgements of Meeting Staff / Plinio SIST / ATBC 2016 Program Chair

Handover of power between Plinio SIST (ATBC 16 Program Chair) and Miguel MARTINEZ RAMOS (ATBC17 Program Chair)

Declaration Robin CHAZDON ATBC Executive Director

■ AWARDS

AWARDS FOR STUDENTS AND RECENT PHD DEGREE RECIPIENTS
The Bacardi Awards are open to those who have received a PhD, within 5 years of the meeting dates.
To be eligible for the Bacardi Award, an applicant must be a non-student member for 2016 or have just completed the PhD in Spring 2016. For more information on the award, please see:
http://tropicalbiology.org/luis-f-bacardi-award/

The Alwyn Gentry Award is presented to a student presenter (one each – oral or poster). Minimum qualification is to be a paying student member of the ATBC for 2016. For details of the award, please see: **http://tropicalbiology.org/alwyn-gentry-award/**

New Phytologist Trust

News Phytologist Poster Prize, $200, will be presented to the Best Poster.

■ BUSINESS MEETINGS AND SPECIAL GROUP MEETINGS

By invitation only.

ATBC COUNCIL MEETING (Sunday 19)
Details sent to the ATBC officers, councilors and additional invited participants.

ATBC Conservation committee MEETING (date TBA)
Details sent to the ATBC officers, councilors and additional invited participants.

BIOTROPICA EDITORS MEETING (date TBA)
Invitation to this dinner and discussion event will be sent to all relevant editors of Biotropica.

PROGRAM AT A GLANCE

SUNDAY 19 JUNE 2016																	
08:00	08:30	09:00		09:30	10:00	10:30	11:00	12:00	13:30	14:30	15:30	16:00	17:00	17:30	18:00	18:30	19:00
Arrivals									Registration						**Opening Conference**		**Welcome Cocktail**

MONDAY 20 JUNE 2016											
Registration	**Opening Welcome**	**Plenary Session 1** Kaoru KITAJIMA Women in tropical biology and conservation	Break	**Symposia & Free Sessions**	Lunch & Lunch Sessions	**Plenary Session 2** Robert NASI Tropical wildlife: a forgotten and threatened forest resource	**Symposia & Oral Sessions**	Break	**Symposia & Oral Sessions**	Poster Sessions	**ATBC Town Hall Meeting**

TUESDAY 21 JUNE 2016										
Registration	**Plenary Session 3** Karen KAINER Collaboration challenges and possibilities between local communities and scientists for shared learning and long-term conservation	Break	**Symposia**	Lunch & Lunch Sessions	**Plenary Session 4** Joachim CLAUDET Challenges in using human-nature interactions to better inform policy and assess management outcomes	**Symposia & Oral Sessions**	Break	**Symposia & Oral Sessions**	Poster Sessions	**Gender Committee Workshop**

WEDNESDAY 22 JUNE 2016										
Registration	**Symposia, Oral Sessions & Free Sessions**	Break	**Symposia & Oral Sessions**	Lunch & Lunch Sessions	**Plenary Session 5** Marielos PENA-CLAROS Conserving tropical forests: the potential role of sustainable forest management	**Symposia & Oral Sessions**	Break	**Symposia & Oral Sessions**	Poster Sessions	**Photo Conference**

THURSDAY 23 JUNE 2016										
Symposia & Oral Sessions	Break	**Symposia**	Lunch & Lunch Sessions	**Plenary Session 6** Tuyeni MWAMPAMBA The future role and key challenges of biodiversity conservation and use in Africa	**Symposia, Oral Sessions & Free Sessions**	Break & poster Sessions	**Symposia & Oral Sessions**	Interlude	Closing ceremony, The Montpellier Declaration	**ATBC Banquet**

PROGRAM DETAILED

Sunday 19 June 2016

13:30 **REGISTRATION** — *Registration Desk (Level 1)*

18:00 **OPENING CONFERENCE** — *Pasteur (Level 0 & 1)*

19:00 **WELCOME COCKTAIL** — *Corum Rooftop - TBC*

Monday 20 June 2016

08:00 **REGISTRATION** — *Registration Desk (Level 1)*

09:00 **OPENING WELCOME** — *Pasteur (Level 0 & 1)*

09:30 **PLENARY SESSION 1** — *Pasteur (Level 0 & 1)*
Kaoru KITAJIMA, Kyoto University
Women in tropical biology and conservation

10:30 - 11:00 Break (Level 1 & 2)

11:00 **SYMPOSIA & FREE SESSION**

S1 | Defaunation: a local process with global implications
Pasteur (Level 0 & 1)
TERBORGH John, PAINE C. E. Timothy, PRINGLE Elizabeth, HAZELWOOD Kirsten

11:00	ABERNETHY Katharine - Hunting wildlife: out of the frying pan and into the fire?	O1-01
11:15	TROLLIET Franck - Influence of frugivore taxa on the generation of plant recruitment foci and on the composition of plant recruits' communitie	O1-02
11:30	EFFIOM Edu - The effects of hunting and competition on germination and survival among tropical tree seedlings	O1-03
11:45	OLSSON Ola - Functional traits among tropical tree seedling communities shift in response to hunting	O1-04

S2 | Success of tropical legumes and traits that contribute to their dominance
Einstein (Level 0)
GEI Maria, DEXTER Kyle, POWERS Jennifer

11:00	PENNINGTON R. Toby - Patterns of niche evolution across the legume phylogeny and their relevance for understanding the historical assembly of neotropical biomes	O2-01
11:15	LEHMANN Caroline - All legumes are not equal: understanding legume dominance across the tropics	O2-02
11:30	KOENEN Erik - Temporal diversity dynamics of mimosoid legumes, a key ecological component of global tropical biomes	O2-03
11:45	POWERS Jennifer - Tropical dry forest legumes aren't just different-they are better	O2-04

Program detailed

Monday 20 June 2016

S4 | **Termites, earthworms and tropical soils: thier diversity and conservation**
Sully 1 (Level 1)
DECAENS Thibaud, FREYCON Vincent, MCKEY Doyle, JIMENEZ Juan Jose

11:00	DA SILVA Elodie - DNA barcode for earthworm taxonomy, biodiversity assessment and conservation of Brazilian species	O4-01
11:15	DECAËNS Thibaud - Diversity and structure of tropical earthworm communities as revealed by DNA barcoding	O4-02
11:30	JIMÉNEZ Juan J. - Multi-scale spatial analysis of tropical earthworm assemblages – Biotic interactions and environmental drivers	O4-03
11:45	MCKEY Doyle - Earthworms and spatially self-organized landscapes in seasonal tropical wetlands	O4-04

| **Free session**
Sully 3 (Level 1)

S7 | **The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest**
Antigone 1 (Level 2)
LOHMANN Lucia, CARNAVAL Ana Carolina

11:00	CRUZ Francisco - Paleo-Precipitation patterns in South America during the last glacial-interglacial cycles: Implications for Amazon and Atlantic forest connections	O7-01
11:15	LEDRU Marie-Pierre - Changes in the Atlantic forest and links with Amazonia through time	O7-02
11:30	CARNAVAL Ana Carolina - Sub-genomic data shed new light on species response to climate change in the South American rainforests	O7-03
11:45	LOHMANN Lúcia - Tempo and mode of biotic interchanges between Amazonia and the Atlantic Forest domains: evidence from multiple plant clades	O7-04

S9 | **Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)**
Antigone 3 (Level 2)
FONTY Emile, HEURET Patrick, DE RIDDER, CARAGLIO Yves, OUEDRAOGO Dakis-Yaoba

11:00	ZUIDEMA Pieter - Reconstructing growth trends from tree-ring data: can we account for biases?	O9-01
11:15	CUNY Henri - Woody biomass production lags stem-girth increase by over one month in temperate forests: what to expect for the tropics?	O9-02
11:30	RIDDER Maaike - Current tree-ring research and potential in tropical Africa: case-study on commercial timber species from the Democratic Republic of Congo	O9-03
11:45	CARAGLIO Yves - Understanding plant growth dynamics: links between morpho-anatomical structure and phenology	O9-04

Program detailed

Monday 20 June 2016

S11 | Tropical tree physiology / Part 1
Adaptations and responses to changes in soil water availability tropical tree physiology
Rondelet (Level 2)
GOLDSTEIN Guillermo, SANTIAGO Louis S.

11:00	SANTIAGO Louis - Drought survival strategies of tropical trees	O11Part1-01
11:15	BUCCI Sandra - Physiological significance of hydraulic segmentation, nocturnal transpiration and capacitance: paradigms revisited	O11Part1-02
11:30	CERNUSAK Lucas - The stable isotope fingerprint of Australian tropical rainforests	O11Part1-03
11:45	SAYER Emma - Nutrient limitation in lowland tropical forests – lessons learned from fertilization experiments	O11Part1-04

S13 | Biodiversity conservation in a conflicting context - The case of the Congo basin
Barthez (Level 2)
DOUMENGE Charles, PALLA Florence, REGNAUT Sébastien

11:00	LEBERGER Roxanne - Identifying unique areas in the Congo Basin for conservation	O13-01
11:15	ROGGERI Paolo - IMET (Integrated Management Effectiveness Tool): an integrated tool for the Planning, Monitoring & Evaluation of protected areas	O13-02
11:30	BAYOL Nicolas - Scientifically based biodiversity management in timber concessions: contribution to conservation and sustainable use of biodiversity	O13-03
11:45	GOULAOUIC Robin - Spatial modeling of the potential of agricultural or forestry production for sustainable land use planning	O13-04

12:00 - 13:30 Lunch & Lunch Sessions (Level 3)

13:30 **Plenary Session 2** *Pasteur (Level 0 & 1)*
Robert Nasi, Deputy Director General-Research, CIFOR
Tropical wildlife: a forgotten and threatened forest resource

14:30 Symposia & Oral Sessions

S1 | Defaunation: a local process with global implications
Pasteur (Level 0 & 1)
TERBORGH John, PAINE C. E. Timothy, PRINGLE Elizabeth, HAZELWOOD Kirsten

14:30	BRETAGNOLLE François - The consequences of defaunation on the tree-frugivore network in Central African forests	O1-05
14:45	BOISSIER Olivier - Parallel impacts of defaunation over seed removal by frugivores and dung beetle communities in a tropical rain forest	O1-06
15:00	PERES Carlos - Functional transitions in tree assemblages in semi-defaunated forest islands following 26 years of isolation	O1-07
15:15	MUNOZ Marcia Carolina - Importance of animal and plant traits for fruit removal and seedling establishment in a tropical forest	O1-08

Monday 20 June 2016

S2 | **Success of tropical legumes and traits that contribute to their dominance**
Einstein (Level 0)
GEI Maria, DEXTER Kyle, POWERS Jennifer

14:30	KURSAR Thomas - Do anti-herbivore defenses facilitate dominance by legumes in tropical wet forests?	O2-05
14:45	MEAVE Jorge A. - The legumes of a Mexican tropical dry landscape: a success story based on their high ecological divergence	O2-06
15:00	GEI Maria - Distribution of legumes across successional gradients in the Neotropics	O2-07
15:15	TRIERWEILER Annette - The role of N2-fixating legumes in neotropical dry forests: insights from ecosystem modeling	O2-08

S4 | **Termites, earthworms and tropical soils: thier diversity and conservation**
Sully 1 (Level 1)
DECAENS Thibaud, FREYCON Vincent, MCKEY Doyle, JIMENEZ Juan Jose

14:30	TAHERI Shabnam - Phylogenetic assessment within a complex of tropical peregrine species, Pontoscolex corethrurus	O4-05
14:45	CHAUDHARY Ekta - Origin and dynamic of cathedral and lenticular mounds in Southern Indian forests	O4-06
15:00	LOUPPE Dominique - Should we fear termites?	O4-07
15:15	ROISIN Yves - What do humus-feeding soldierless termites really feed on?	O4-08

S6 | **Free session: Experimental methods in tropical ecology**
Sully 3 (Level 1)

14:30	SCHNITZER Stefan - Quantifying the role of lianas in tropical forests: results from liana removal experiments in the Republic of Panama	O6-01
14:45	SMITH Christina - Are dry seasons helping lianas?	O6-02
15:00	HOMEIER Jürgen - Effects of continued N and P addition on Ecuadorian Andean forests	O6-03
15:15	HOFHANSL Florian - Amazon forest ecosystem responses to elevated atmospheric CO2: filling the gaps with model-experiment integration	O6-04

S8 | **Free session: Land use, landscape ecology, and conservation**
Antigone 1 (Level 2)

14:30	BOUCHER Doug - What commodity is the most important driver of tropical deforestation?	O8-01
14:45	CUTHBERT Richard - Conserving landscapes, species and cultures in Papua New Guinea	O8-02
15:00	ABRAHAMS Mark - Living with the enemy; crop raiding in Brazilian Amazonia	O8-03
15:15	DONALDSON Lynda - Is the multifunctional use of wetlands compatible with African bird conservation?	O8-04

Monday 20 June 2016

S9 | Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)
Antigone 3 (Level 2)
FONTY Emile, HEURET Patrick, DE RIDDER, CARAGLIO Yves, OUEDRAOGO Dakis-Yaoba

14:30	MOREL Hélène - Studying phenology of tropical forest trees using a morphological and anatomical retrospective analysis: the case of Moronobea coccinea Aubl. (Clusiaceae)	O9-05
14:45	BOSSU Julie - Cordia alliodora (Boraginaceae) as a candidate for tree plantations in French Guiana: characteristics and development of natural populations in Saül vicinity	O9-06
15:00	HEURET Patrick - Retrospective analysis of plant architecture: an extended definition of dendrochronology	O9-07
15:15	WANG Kang Han - Cambial activity of selected tropical trees in relation to different stem sizes and climatic factors growing in Malaysian rain forest	O9-08

S11 | Tropical tree physiology / Part 1
Adaptations and responses to changes in soil water availability tropical tree physiology
Rondelet (Level 2)
GOLDSTEIN Guillermo, SANTIAGO Louis S.

14:30	DE DEURWAERDER Hannes - Tapping another source: lianas' and trees' below ground competition for water	O11Part1-05
14:45	PAROLIN Pia - Flood tolerant trees in seasonally inundated lowland tropical floodplains	O11Part1-06
15:00	RENNINGER Heidi - Distribution and physiology of palms in response to global environmental change	O11Part1-07
15:15	ÁVILA-LOVERA Eleinis - Do photosynthetic stems have higher water use efficiency than leaves? Implications for drought responses of tropical and subtropical plants	O11Part1-08

S13 | Biodiversity conservation in a conflicting context - The case of the Congo basin
Barthez (Level 2)
DOUMENGE Charles, PALLA Florence, REGNAUT Sébastien

14:30	DE WACHTER Pauwel - The case for a "conservation bank" to secure the future of the TRIDOM forest landscape	O13-05
14:45	VERMEULEN Cédric - Place of customary rights mapping initiatives in conservation policies	O13-06
15:00	GUIGNIER Armelle - A legal approach to biodiversity conservation and forest rights of indigenous peoples in the Congo Basin: towards new legal tools	O13-07
15:15	TADOUM Martin - The OFAC: Interface between science and policy decisions on forest conservation and protected areas	O13-08

15:30 - 16:00 Break (Level 1 & 2)

SCIENTIFIC PROGRAM

PROGRAM DETAILED

Monday 20 June 2016

16:00 **SYMPOSIA & ORAL SESSIONS**

S1 | Defaunation: a local process with global implications
Pasteur (Level 0 & 1)
TERBORGH John, PAINE C. E. Timothy, PRINGLE Elizabeth, HAZELWOOD Kirsten

16:00 VILLAR Nacho - Large herbivores modulate vegetation communities and net primary productivity in tropical forests O1-09

16:15 HAZELWOOD Kirstie - Hunting-induced defaunation causes long-term shifts in tree community composition O1-10

16:30 PRINGLE Elizabeth - Consequences of defaunation for wood density and carbon storage in a tropical forest O1-11

16:45 BELLO Carolina - Carbon loss induced by large frugivores defaunation and its relations with landscape structure O1-12

17:00 WAEBER Patrick O. - Natural born gardeners – extant tortoises to fight defaunation? O1-13

17:15 BERZAGHI Fabio - A modeling approach to study the role of megafauna in tropical forest dynamics O1-14

S3 | Model systems for studying the ecology and evolution of herbivore defence
Einstein (Level 0)
DEXTER Kyle

16:00 COLEY Phyllis - Is the high diversity in tropical forests driven by the interactions between plants and their pests? O3-01

16:15 FINE Paul - Coevolutionary chemical arms races in a world of generalist insect herbivores O3-02

16:30 SALAZAR Diego - Testing the effect of plant chemical and phylogenetic diversity on herbivore damage and local community assembly O3-03

16:45 ENDARA Maria Jose - Herbivores on plants: ecological tracking or coevolutionary arms-race? O3-04

17:00 SEDIO Brian - The role of defense-chemical divergence in maintaining species richness in hyperdiverse tropical tree genera O3-05

17:15 STONE Graham - Trans-Amazonian patterns in the richness and diversity of insect herbivores of neotropical Inga trees O3-06

S5 | Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics
Sully 1 (Level 1)
LEDRU Marie-Pierre, FAVIER Charly

16:00 HOORN Carina - The Andes-Amazonian system and the effects of Neogene landscape changes on plant composition O5-01

16:15 HOOGHIEMSTRA Henry - Pleistocene evolution of floristic assemblages in the northern Andes O5-02

16:30 MCMICHAEL Crystal - Holocene Variability of an Amazonian Hyperdominant O5-03

16:45 BREMOND Laurent - Lessons from the past for future management of protected areas in East Africa O5-04

17:00 GOSLING William - Assessing human impacts on the vegetation of the biodiverse eastern Andean flank before, and after, the arrival of Europeans (AD 1492) O5-05

17:15 SILVA DE MIRANDA Pedro Luiz - Determining which are the main biomes of lowland tropical South America and how they differ by using a massive dataset of tree species community surveys O5-06

S6 | Free session: Experimental methods in tropical ecology

Sully 3 (Level 1)

16:00 FISCHER Rico - How much forest area should be sampled to get accurate biomass estimations? O6-05

16:15 MELO Omar - Effect of population density of Cordia alliodora R. & P (Boraginaceae) in the functionality seedlings bank and understory diversity in the tropical dry forests. Colombia South America O6-06

16:30 LEHMANN Sebastian - A size-structured, spatially explicit symmetric model of tropical rain forest predicts multiple community patterns at once O6-07

16:45 STRASSBURG Bernardo - Spatial prioritization for restoration of the Brazilian Atlantic Forest O6-08

17:00 CIMADOM Arno - Living at the edge: The impact of an introduced parasite and habitat change on the breeding success of Darwin's finches O6-09

17:15 SELTMANN Anne - Body condition and immune function is impaired by habitat disturbance in forest-dwelling paleotropical bats O6-10

S8 | Free session: Land use, landscape ecology, and conservation

Antigone 1 (Level 2)

16:00 SIERRA CORNEJO Natalia - Fine root biomass along an elevational and land use gradient in Mt. Kilimanjaro O8-05

16:15 VOLLSTAEDT Maximilian - Effects of land-use and climate on seed-dispersal networks on Mt.Kilimanjaro, Tanzania O8-06

16:30 SUTUMMAWONG Nantida - The fate of Thailand's tropical birds under the synergistic impacts of climate change and land use change O8-07

16:45 MASTERS Karen L. - Lattice-work corridors for climate change: a conceptual framework for biodiversity conservation and social-ecological resilience in a tropical elevational gradient O8-08

17:00 ORTA-MARTINEZ Marti - Oil in tropical rainforests revisited: a major threat to their future? O8-09

17:15 PAZ Sherryl - Wildlife and their Preferred Habitats in Selected Key Mining Areas of Mindanao: Basis for Policy Reform and Biodiversity Conservation O8-10

S10 | Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests

Antigone 3 (Level 2)

FAYOLLE Adeline, BEECKMAN Hans, STOFFELEN Piet, VAN ACKER Joris, DE RIDDER Maaike

16:00 BEECKMAN Hans - Can wood collections contribute to the understanding of ecosystem dynamics? Updating a century old xylarium. O10-01

16:15 CARRÉ Benoît - "To wake a sleeping beauty": the classification and scientific potential of the tropical wood collections at the Natural History Museum in Paris O10-02

16:30 DEKLERCK Victor - Methodology to use Xylarium specimens to generate wood technological output O10-03

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16:45 JANSSENS Steven - Sleeping beauties are awakening: the story of the African herbarium of the Botanic Garden Meise, Belgium O10-04

17:00 OUÉDRAOGO Dakis-Yaoba - The reproductive phenology of central African tree species: combining field observations and herbarium records O10-05

17:15 HUFKENS Koen - Two decades of historical phenology observations of African tropical tree species: exploring the past to predict the future O10-06

S12 | Free session: Plant physiology, and ecology

Rondelet (Level 2)

16:00 DEWALT Saara - Morphological and genetic variation in native and introduced Clidemia hirta O12-01

16:15 MARTINS Valeria - The effects of intra- and interspecific competition on mortality and growth of tropical tree seedlings O12-02

16:30 VERRYCKT Lore - How do the photosynthetic capacity parameters Vcmax and Jmax vary along local nutrient availability gradients in the primary tropical rain forests in French Guiana? O12-03

16:45 BINKS Oliver - Plasticity in the water relations and anatomy of leaves of tropical rainforest trees in response to experimental drought O12-04

17:00 GARCIA Laure Alejandra - Functional responses of species of the genus Zamia (ZAMIACEAE - Cycadales) by human disturbances in its light habitat in tropical rainforests of the Biogeographic Chocó, Colombia - South America O12-05

17:15 SANCHEZ Adriana - Seasonal variation of leaf temperature in two common species of the paramo O12-06

S14 | Mapping diversity: from gene to system

Barthez (Level 2)

HUGHES Alice

16:00 HUGHES Alice - Mapping diversity and distributions across spatio-temporal scales; capturing the details O14-01

16:15 NAKA Luciano - Patterns of taxonomic, phylogenetic, and functional avian diversity along a rainfall gradient on the Rio Branco basin, a white-water Amazonian River O14-02

16:30 WESTOBY Mark - Three strands of progress in plant ecological strategies O14-03

16:45 CILLEROS Kévin - Scale-dependent determinants of taxonomic diversity of freshwater fish assemblages in small streams of French Guiana O14-04

17:00 GAUBERT Philippe - Appraisal and prospects on pangolin DNA forensics: how DNA may help tracing the trade of the most heavily poached mammals? O14-05

17:15 NEVES Danilo - Environmental harshness determines macroscale patterns of floristic turnover across South American woody plant communities O14-06

17:30 **Poster Sessions** *Poster Area (Level 1)*

18:30 **ATBC Town hall meeting** *Pasteur (Level 0 & 1)*

Program detailed

Tuesday 21 June 2016

08:00 **Registration** *Registration Desk (Level 1)*

08:30 **Plenary Session 3** *Pasteur (Level 0 & 1)*
Karen KAINER, Professor University of Florida
Collaboration challenges and possibilities between local communities and scientists for shared learning and long-term conservation

09:30 - 10:00 Break (Level 1 & 2)

10:00 **Symposia**

S15 | **Ecosystem ecology of african forests**
Pasteur (Level 0 & 1)
MOORE Sam, ADU-BREDU Stephen, MITCHARD Edward, CARDOSA Anabelle

10:00 MALHI Yadvinder - The variation of productivity and its allocation between African, Asian and Neotropical forests O15-01

10:15 MOORE Sam - Carbon cycling across environmental gradients in West and Central African tropical forests O15-02

10:30 ADU-BREDU Stephen - Soil and Necromass Carbon Dioxide efflux in a moist semi-deciduous forest under recovery from selective logging in Ghana O15-03

10:45 LEWIS Simon - Comparative Ecology of African Tropical Forests: A pan-tropical synthesis O15-04

11:00 BARBIER Nicolas - Regional scale mapping of forest types, biomass and degradation in Cameroon using a ground inventory network and canopy texture on VHR optical imagery O15-05

11:15 WHEELER Charlotte - Carbon sequestration and biodiversity following active tropical forest restoration: 18 years of change in Kibale National Park, Uganda O15-06

11:30 TERBORGH John - Comparing the Foraging Impacts of Asian vs. African Forest Elephants on Tropical Forest Structure and Biodiversity O15-07

11:45 POULSEN John - The aboveground biomass of Gabon's forests O15-08

S17 | **Palm ecology in a changing world**
Einstein (Level 0)
DRACXLER Caroline Marques, PORTELA RITA DE CÁSSIA Quitete, PIRES DOS SANTOS Alexandra

10:00 SVENNING Jens-Christian - Macroecological perspectives on palm diversity in a changing world O17-01

10:15 PORTELA RITA DE CASSIA Quitete - Effects of "primatization" on the population dynamic of a palm tree that is vulnerable of extinction O17-02

10:30 VISSER Marco - Population-level effects of hunting on seed dispersal, seed predation and population abundance in the Neotropical palm Attalea butyracea O17-03

10:45 CARVALHO Carolina - Local and landscape scale determinants of gene dispersal of a tropical palm O17-04

11:00 QUEENBOROUGH Simon - Where do all the (dioecious) flowers go? Diversity and distribution of breeding systems in Neotropical palms O17-05

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11:15 BECKMAN Noelle G. - Spatial patterns of seed predation by a specialized invertebrate O17-06

11:30 MORGAN Emma - Keeping it in the family: Genetic implications of limited seed dispersal for Coco de Mer, the largest-seeded plant in the world O17-07

11:45 THAISE Emilio - Drought-driven decline of palm hyperdominance in an Amazonian forest O17-08

S19 | Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments

Sully 1 (Level 1)

MCGUIRE Krista, SELOSSE Marc-André, BREARLEY Francis

10:00 BREARLEY Francis - Ectomycorrhizal fungal diversity: comparing techniques for enumeration at Pasoh Forest Reserve  (Malaysia) O19-01

10:15 SEGNITZ Max - Plant-soil feedbacks across host mycorrhizal strategies in a mixed Dipterocarp forest O19-02

10:30 ROY Mélanie - High diversity and high specificity of ectomycorrhizal fungi communities associated with trees from low canopy forests in French Guiana O19-03

10:45 TAYLOR Joe - Mycorrhizal diversity in tropical forests: feedbacks between root-fungal symbioses and soil phosphorus partitioning O19-04

11:00 PANDOLFO PAZ Claudia - Recovery of arbuscular mycorrhizal fungi community during tropical forest succession in two soil types O19-05

11:15 BACHELOT Benedicte - Preferential carbon allocation to arbuscular mycorrhizal fungi and fungal coexistence in tropical rainforests O19-06

11:30 SARMIENTO Carolina - Experimental manipulation of fungal communities reveals host-specific effects on seed persistence and survival O19-07

11:45 MEYER Kyle - Spatial patterns of soil bacterial communities in a lowland Central African Rainforest and sites undergoing agricultural conversion O19-08

S21 | The ecological importance of tank-forming plants in tropical rainforests

Sully 3 (Level 1)

CEREGHINO Regis, GAUME Laurence

10:00 GAUME Laurence - The pitcher of carnivorous plants: grave or sanctuary for arthropods? The biotic and abiotic drivers of 'living' diversity in the traps of Nepenthes O21-01

10:15 YULE Catherine - Food webs of phytotelmata in Mulu National Park, Borneo O21-02

10:30 SRIVASTAVA Diane - Geographic constancy and contingency in the sensitivity of bromeliad food webs to precipitation change O21-03

10:45 CEREGHINO Regis - Functional trait responses of bromeliad invertebrate communities to altered precipitation along a biogeographic gradient O21-04

11:00 AMUNDRUD Sarah - Drought indirectly affects a bromeliad food web by altering predator survival and omnivory O21-05

11:15 LEROY Celine - Contribution of microorganisms and metazoans to leaf litter decomposition and tank bromeliad mineral nutrition O21-06

11:30 GUZMAN Laura Melissa - Bromeliad macro-invertebrate food web stability is driven by higher handling time with increasing prey body mass O21-07

11:45 FERNANDEZ BARRANCOS Estefania - Bromeliad transplantation buffers microclimate fluctuations and facilitates arthropod diversity in tropical forest restoration O21-08

Tuesday 21 June 2016

S24 | The future of tropical montane forests: biodiversity, climate change, land use, and conservation

Antigone 1 (Level 2)
GEML József, LEONARD Jennifer, TER STEEGE Hans

10:00	LEONARD Jennifer - Divergence and Convergence in High Altitude Specialists	O24-01
10:15	RAMIREZ Beatriz - Hydro-meteorological spatio-temporal variability in an eastern Andean Tropical montane cloud forest (Orinoco River Basin)	O24-02
10:30	BAEZ Selene - Spatial and temporal patterns of turnover and productivity in Northern Andean forests	O24-03
10:45	GEML József - DNA metabarcoding reveals common patterns in altitudinal turnover of functional groups of fungi in Borneo and in the Andes	O24-04
11:00	ASHTON Louise - Elevational sensitivity in an Asian 'hotspot': moth diversity across elevational gradients in tropical, sub-tropical and sub-alpine China	O24-05
11:15	RAES Niels - Altitudinal range shifts of plants on Sundaland as result of predicted future climate change	O24-06
11:30	WHITAKER Jeanette - The importance of microbial community composition in determining climate change effects on soil carbon cycling in the tropical Andes	O24-07
11:45	AGUIRRE GUTIÉRREZ Jesús - Similar but not equivalent: ecological niche comparison across closely-related Mexican white pines	O24-08

S26 | Ecological impacts of forest disturbance in the brazilian amazon

Antigone 3 (Level 2)
FERREIRA Joice, SIST Plinio

10:00	FERRAZ Silvio - A spatial-temporal framework to assess tropical forest disturbance	O26-01
10:15	MAGNABOSCO MARRA Daniel - Windthrows affect biomass stocks and balance in Central Amazon forests	O26-02
10:30	FERREIRA Joice - Prioritizing forest protection, reforestation, and avoided disturbance in the eastern Amazon	O26-03
10:45	JONES Isabel - Extinction debt on reservoir land-bridge islands	O26-04
11:00	GONTIJO LEAL Cecilia - Small rivers, big impacts: environmental disturbances to aquatic biodiversity in Eastern Amazon	O26-05
11:15	LEVIS Carolina - Legacies of human history in Amazonian forests	O26-06
11:30	JAKOVAC Catarina - Agricultural intensification and forest degradation in riverine Amazonia	O26-07
11:45	JUNQUEIRA André - Lessons from farmers' use of anthropogenic soils to sustainable agriculture	O26-08

Program detailed

Tuesday 21 June 2016

S11 | **Tropical tree physiology / Part 2**
Adaptations and responses to changes in nutrient and light resources
Rondelet (Level 2)
GOLDSTEIN Guillermo, SANTIAGO Louis S.

10:00	GOLDSTEIN Guillermo - Facing shortage or excessive light: how tropical and subtropical trees adjust their photosynthetic behavior and life history traits to a dynamic forest environment	O11Part2-01
10:15	SILVERA Katia - Functional diversification of Crassulacean Acid Metabolism in tropical epiphytic orchids	O11Part2-02
10:30	RUSSO Sabrina E. - Ecophysiology of leaf lifespan in tropical forests: adaptive and plastic responses to environmental heterogeneity	O11Part2-03
10:45	TORRES Michael - Drought resistance of tropical relict species in subtropical arid shrublands of southern California	O11Part2-04
11:00	YOKOYAMA Daiki - Dependence of P-limited tropical rainforest trees on different soil organic P fractions as a P source inferred from an NP fertilization experiment in Borneo	O11Part2-05
11:15	DALLING James - Nutrient availability in tropical rain forests: the paradigm of phosphorus limitation	O11Part2-06
11:30	DOMINGUES Tomas - Leaf traits and environmental factors: Searching for relationships for tropical forests and savannas	O11Part2-07
11:45	DE GUZMAN Mark - Hydraulic strategies of vessel occluding plants in lowland tropical forest	O11Part2-08

S29 | **Impacts of drought on tropical forests: processes and tipping points**
Barthez (Level 2)
ZANNE Amy, CERNUSAK Lucas, CHEESMAN Alex

10:00	CHEESMAN Alexander - Susceptibility of tropical forests to drought: should we expect continents to differ?	O29-01
10:15	DEXTER Kyle - The relative evolutionary rarity of drought adaptation revealed by community phylogenetic analyses across lowland tropical South America	O29-02
10:30	FELDPAUSCH Ted - Amazon forest response to the 2010 drought	O29-03
10:45	HIROTA Marina - Drought-related resilience and tipping points in tropical rainforests	O29-04
11:00	KUMAGAI Tomo'omi - Modelling of drought-induced tree mortality in a Bornean tropical rainforest	O29-05
11:15	LAURANCE Susan - The Daintree Drought Experiment	O29-06
11:30	MEIR Patrick - The effects of drought on respiration in tropical rainforest	O29-07
11:45	MARÉCHAUX Isabelle - The diversity of drought tolerance, as predicted by leaf water potential at turgor loss point, within an Amazonian forest.	O29-08

12:00 - 13:30 Lunch & Lunch Seesions (Level 3)

Tuesday 21 June 2016

13:30 **PLENARY SESSION 4** *Pasteur (Level 0 & 1)*

Joachim CLAUDET, Researcher, CNRS

Challenges in using human-nature interactions to better inform policy and assess management outcomes

14:30 SYMPOSIA & ORAL SESSIONS

S15 | Ecosystem ecology of african forests

Pasteur (Level 0 & 1)

MOORE Sam, ADU-BREDU Stephen, MITCHARD Edward, CARDOSA Anabelle

14:30	JEFFERY Kathryn - Future perspectives from historical data : addressing the data-gap in Central Africa	O15-09
14:45	GVOZDEVAITE Agne - Photosynthetic capacity dynamics along forest-savannah transition in West Africa	O15-10
15:00	MITCHARD Edward - Woody expansion in Africa's savannas: extent and drivers	O15-11
15:15	NYIRAMBANGUTSE Brigitte - Aboveground biomass production and carbon storage at different successional stages in an Afromontane tropical forest	O15-12

S18 | Tropical plant-animal interactions in the anthropocene

Einstein (Level 0)

KUPREWICZ Erin, GARCIA-ROBLEDO Carlos

14:30	GARCIA-ROBLEDO Carlos - Using molecular tools to model cascades of extinctions under projected global warming: plant, insect herbivores and phoretic mite interactions along a tropical elevational gradient	O18-01
14:45	MAUNSELL Sarah - Insect herbivores and herbivory across the Stability of Altered Forest Ecosystems (SAFE) gradient of habitat modification in Borneo	O18-02
15:00	MAYR Antonia - Bees, wasps and their antagonists along an elevational gradient at Mount Kilimanjaro: effects of climate and land use	O18-03
15:15	KUPREWICZ Erin - Barriers to plant migrations in the Anthropocene: Changes in mammal seed dispersal along an elevational gradient	O18-04

S19 | Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments

Sully 1 (Level 1)

MCGUIRE Krista, SELOSSE Marc-André, BREARLEY Francis

14:30	SOMMERIA-KLEIN Guilhem - Topic modeling of a DNA-based biodiversity survey reveals spatial motifs in 12 ha of neotropical forest	O19-09
14:45	AMMA Sarasa - Microbial dynamics in long-term monitoring plots in Thailand: analysis of the composition and diversity of soil fungi in seasonal tropical forests in Thailand with massive parallel DNA sequencing	O19-10
15:00	MCGUIRE Krista - Plant-microbial associations across land use gradients in tropical forests	O19-11
15:15	SELOSSE Marc-André - From terrestrial to epiphytic orchids: do tropics change the rules as compared to temperate regions?	O19-12

Tuesday 21 June 2016

S22 | Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture

Sully 3 (Level 1)

BLATRIX Rumsais, MCKEY Doyle, RENARD Delphine

14:30 ZANGERLE Anne - A biocultural earth-mound landscape : interactions between termites, earthworms and pre-Columbian raised fields in the Beni Llanos of Bolivia O22-01

14:45 SEYMOUR Colleen - Termite mounds as islands of fertility islands and climate regulation in southern Africa O22-02

15:00 GETZIN Stephan - Namibian and other fairy circles: different biomass-water feedbacks but identical spatial patterns - O22-03

15:15 MIDGLEY Jeremy - The origin and demise of SW Cape heuweltjies (“small hills”) O22-04

S24 | The future of tropical montane forests: biodiversity, climate change, land use, and conservation

Antigone 1 (Level 2)

GEML József, LEONARD Jennifer, TER STEEGE Hans

14:30 FARFAN-RIOS William - Upslope Andean tree migration is due to pervasive range contraction O24-09

14:45 GRAHAM Catherine - The influence of land-use and climate change on hummingbird diversity in the Andes O24-10

15:00 SILMAN Miles R. - The future of forests of the Andes to Amazon gradient: Connecting biodiversity, community composition, and ecosystem services under climate change O24-11

15:15 YOUNG Kenneth - Conservation planning for tropical montane forests O24-12

15:30 TER STEEGE Hans - Naturalis Biodiversity Center S24-Conclusion

S27 | Long-term trends of tropical plant phenology: consequences for plants and consumers

Antigone 3 (Level 2)

MENDOZA Irene, ABERNETHY Katharine, BUSH Emma, BUNNEFELD Nils, MORELLATO Patricia, FORGET Pierre-Michel

14:30 BUSH Emma - Are we heading towards fruit-less forests? Quantitative signatures of change in reproductive cycles of African forests O27-01

14:45 USHIO Masayuki - Identifying triggers of general flowering in a tropical lowland forest in Borneo O27-02

15:00 SUN I Fang - Effects of ENSO and spring frost on flower and seed production in a subtropical rain forest O27-03

15:15 CHEN Yu-Yun - Plant reproductive output altered by selective logging has profound effect on forest regeneration in lowland dipterocarp forests O27-04

Program detailed

Tuesday 21 June 2016

S28 | Primates on the move: from local to landscape scale

Rondelet (Level 2)

HUYNEN Marie, CULOT Laurence

14:30 HUYNEN Marie-Claude - Space use and directness to out-of-sight resources in semi-provisioned and wild-feeding groups of Macaca leonina O28-01

14:45 REYNA-HURTADO Rafael - Primates adjust movement strategies with food availability O28-02

15:00 CROFOOT Margaret - Comparative foraging strategies of Neotropical frugivores: Do primates forage 'smarter'? O28-03

15:15 SAVINI Tommaso - Forest types affect seed shadows by white-handed gibbons O28-04

S29 | Impacts of drought on tropical forests: processes and tipping points

Barthez (Level 2)

ZANNE Amy, CERNUSAK Lucas, CHEESMAN Alex

14:30 OLIVEIRA Rafael - Predicting drought susceptibility using hydraulic traits in the Amazon O29-09

14:45 POORTER Lourens - Traits, drought tolerance and the distribution of tropical tree species O29-10

15:00 ROWLAND Lucy - Is sap flow a good indicator of drought-induced mortality risk in tropical rainforest O29-11

15:15 SITCH Stephen - Large-scale modelling of the impact of drought on the land carbon cycle O29-12

15:30 - 16:00 Break (Level 1 & 2)

16:00 Symposia & Oral Sessions

S16 | Understanding ecosystem services in the panama canal watershed: implications for sustainable land management

Pasteur (Level 0 & 1)

HALL Jefferson, VAN BREUGEL Michiel

16:00 HALL Jefferson - Ecosystem service bundling in the Panama Canal Watershed: Implications for land management in the humid steepland tropics O16-01

16:15 PATON Steven - Long-term Climate Patterns in the Panama Canal Region O16-02

16:30 OGDEN Fred - Manifestations of Land Use Effects on Hydrology in the Panama Canal Watershed O16-03

16:45 VAN BREUGEL Michiel - Effects of plant-functional groups on biomass dynamics during early secondary forest succession O16-04

17:00 SALTONSTALL Kristin - Changes in soil microbial diversity across land use types in the Agua Salud O16-05

17:15 VAN BAEL Sunshine - Reforestation with native and exotic timber species: Implications for bird diversity and community composition O16-06

Program detailed

Tuesday 21 June 2016

S18 | Tropical plant-animal interactions in the anthropocene

Einstein (Level 0)

KUPREWICZ Erin, GARCIA-ROBLEDO Carlos

16:00	DRACXLER Caroline - Scatter-hoarding dependence of Astrocaryum sciophilum for seedling recruitment: perspectives for defaunated scenarios	O18-05
16:15	RAZAFINDRATSIMA Onja - Frugivores bias seed-adult tree associations through nonrandom seed dispersal	O18-06
16:30	CARLO Tomas - Avian seed dispersers affect the structure of succesional forests in non-random way	O18-07
16:45	ABDUL Aziz Sheema - Flying foxes in durian orchards – raiders or potential pollinators?	O18-08
17:00	BOSCOLO Danilo - Influence of local and landscape factors on flower visiting bees within Atlantic Forest landscapes	O18-09
17:15	KARTZINEL Tyler - Predicting changes to the food webs of African large herbivores in the Anthropocene	O18-10

S20 | Free session: Plant-microbial interactions

Sully 1 (Level 1)

16:00	FERRER Astrid - Community assembly and decomposer function of aquatic fungi along a salinity gradient	O20-01
16:15	ZANNE Amy - Tropical wood decay: the relative roles of termites and fungi with changing precipitation	O20-02
16:30	DONALD Julian - Microbes drive decomposition and carbon cycling in a rainforest epiphyte microcosm	O20-03
16:45	CARRICONDE Fabian - Ectomycorrhizal fungal biodiversity from New Caledonian rainforests on ultramafic soils	O20-04
17:00	STAHL Clément - Effect of soil type on soil activity in French Guiana	O20-05
17:15	VERBRUGGEN Erik - Relationship between soil fungal communities and plant communities, fertility and climate at multiple scales in French Guiana	O20-06

S23 | Chemical ecology: new insight in comprehending biotic interactions in the tropics

Sully 3 (Level 1)

PROFFIT Magali, DI GIUSTO Bruno, HOSSAERT-MCKEY Martine

16:00	DI GIUSTO Bruno - Food or sex: Solving the pollinator-prey conflict in a carnivorous plant with a whiff of perfume	O23-01
16:15	FRANK Erik - Saving the injured: rescue behavior in the termite hunting ant Megaponera analis	O23-02
16:30	KOBMOO Noppol - Unspecific chemical mediations in highly specific host-pathogen relations between Ophiocordyceps unilateralis and formicine ants	O23-03
16:45	RODRIGUEZ Lillian Jennifer - Insights into diversification of floral chemical signaling in the Ficus-mutualistic pollinator interaction: the case of Ficus septica in Southeast Asia	O23-04
17:00	STEENHUISEN Sandy-Lynn - Trends in floral trait evolution associated with pollinator shifts in Protea (Proteaceae)	O23-05
17:15	YADAV Pratibha - Deciphering a chemical code: Host location mechanisms in non-pollinating ig wasps	O23-06

Tuesday 21 June 2016

S25 | **Harvest as herbivory: New developments in theoretical and empirical models**
Antigone 1 (Level 2)
GAOUE Orou, ZUIDEMA Pieter

16:00	TICKTIN Tamara - Effects of harvest, rainfall and phorophyte (host tree) genus on the population dynamics of an epiphytic bromeliad	O25-01
16:15	JANSEN Merel - Improving harvesting practices of non-timber forest products through smarter modelling: the role of individual heterogeneity	O25-02
16:30	BIALIC-MURPHY Lalasia - Drought and herbivory influence the population dynamics of an island endemic shrub, Schiedea obovata	O25-03
16:45	STAVER A. Carla - Seasonal feeding strategies determine population size among savanna herbivores	O25-04
17:00	GAOUE Orou - How is combined timber and non-timber forest products harvest possible?	O25-05

S27 | **Long-term trends of tropical plant phenology: consequences for plants and consumers**
Antigone 3 (Level 2)
MENDOZA Irene, ABERNETHY Katharine, BUSH Emma, BUNNEFELD Nils, MORELLATO Patricia, FORGET Pierre-Michel

16:00	ZIMMERMAN Jess - sustainable livelihoods"	O27-05
16:15	MORELLATO Patricia - Long-term trends of flowering phenology: how predictable is the species contribution over time?	O27-06
16:30	MENDOZA Irene - Comparison of long-term trends of reproductive phenology in the Neotropics: challenges for climate-change forecasting	O27-07
16:45	ADAMESCU Gabriela Simina - Impacts of global change on the phenology of African ecosystems	O27-08
17:00	WRIGHT S. Joseph - The environmental regulation of flowering times in tropical moist forests	O27-09
17:15	KAPLIN Beth - Long term phenology of a tropical montane forest: 18 years of fruiting and flowering in Nyungwe National Park, Rwanda	O27-10

S28 | **Primates on the move: from local to landscape scale**
Rondelet (Level 2)
HUYNEN Marie, CULOT Laurence

16:00	ASENSIO Norberto - The ecology of space-use patterns of two sister gibbon species in their contact zone	O28-05
16:15	AGGIMARANGSEE Nantiya - Influence of food provisioning by humans on locomotion of dusky langur (Trachypithecus obscurus Reid, 1837) at Khao Lommuak, Prachuap Khiri Khan, Thailand	O28-06
16:30	CULOT Laurence - Which Factors Shape The Trajectories Of The Black-Lion Tamarins In A Fragmented Landscape?	O28-07
16:45	ALVES-EIGENHEER Milene - Using individual-based models to assess the landscape connectivity for the endangered Golden-Lion Tamarins	O28-08

Tuesday 21 June 2016

17:00 JOHNSON Caspian - Baboon troop movements and their ecological determinants at local and continental scales O28-09

17:15 STRANDBURG-PESHKIN Ariana - Social and environmental factors influence local movement decisions in a troop of wild baboons O28-10

S30 | Manipulation experiments for understanding tropical ecosystem responses to habitat modification

Barthez (Level 2)

ASHTON Louise, GRIFFITH Hannah, PARR Kate

16:00 EGGLETON Paul - A conceptual framework for experimental manipulations in tropical rainforests O30-01

16:15 GRIFFITHS Hannah - Exploring the functional importance of ants in tropical rain forests O30-02

16:30 RIUTTA Terhi - The Borneo rainforest girdling experiment: responses in ecophysiology and soil processes O30-03

16:45 STORK Nigel - Indicator taxa revisited: Tropical forest disturbance causes consistent responses in species composition but not species richness O30-04

17:00 TUMA Jirí - Changes in bioturbation related to logging of rain forest and conversion to oil palm plantation in Borneo O30-05

17:15 WOOD Tana - Tropical responses to altered climate experiment: Initial results from a field warming experiment in Puerto Rico O30-06

17:30 **POSTER SESSIONS** *Poster Area (Level 1)*

18:30 **GENDER COMMITTEE WORKSHOP** *Pasteur (Level 0 & 1)*

Program detailed

Wednesday 22 June 2016

08:00	**Registration**	*Registration Desk (Level 1)*
08:30	**Symposia, Oral Sessions & Free Sessions**	*Pasteur (Level 0 & 1)*

S31 | Next generation forest science, managing and restoring tropical forest genetic resources
Pasteur (Level 0 & 1)
TITO DE MORAIS Claire, KETTLE Christopher J., SCOTTI Ivan

08:30	DICK Christopher - Climatic niche evolution in tropical plants: an Andes-Amazon phylogenomics perspective	O31-01
08:45	MIGLIORE Jérémy - Understanding the history of African shade-tolerant and pioneer rainforest trees, applying new genomic tools to phylogeography	O31-02
09:00	DONKPEGAN Armel S.L. - Evolutionary history in a polyploid complex of African tropical trees: reconstruction of phylogeny, phylogeography and historical changes in the Afzelia genus (Fabaceae-Caesalpinioideae)	O31-03
09:15	DEMENOU Boris - History of the fragmention of the tropical African rain forest in the Dahomey Gap	O31-04

S33 | Free session: The conservation of plant-animal interactions in a changing world
Einstein (Level 0)

08:30	ALBERT-DAVIAUD Aurelie - Structure and robustness of a hyper-diverse seed dispersal network in Thailand	O33-01
08:45	HAUREZ Barbara - Western lowland gorilla and logging companies: a winning duo?	O33-02
09:00	KLIMES Petr - Contrasting tri-trophic food webs between primary and secondary tropical forest: role of species ecology and phylogeny	O33-03
09:15	STUPPY Wolfgang - Dispersal anachronisms in Madagascan legumes: the importance of the extinct megafauna	O33-04

S36 | Free session: Biodiversity and palm oil plantations
Sully 1 (Level 1)

08:30	CHELLAIAH Darshanaa - Effects of Riparian Buffers on Stream Litter decomposition in Oil Palm Plantations in Borneo	O36-01
08:45	GAVEAU David - For decades of forest loss and degradation by expanding oil palm plantations and fires	O36-02
09:00	LIM Norman - Carcass removal by vertebrate scavengers in tropical Borneo: a case of ecological redundancy?	O36-03
09:15	WATANABE Shin - Rehabilitation of Mangrove Ecosystem in Sabah, Malaysian Borneo	O36-04

Program detailed

Wednesday 22 June 2016

S39 | **Capacity building for conservation and sustainable use: challenges and solutions to measuring impact**
Sully 3 (Level 1)
TREVELYAN Rosie, KAPLIN Beth

08:30	TREVELYAN Rosie - Measuring the impact of capacity building: do we know what works?	O39-01
08:45	BATAMULIZA Jeanette - Measuring the intangibles of capacity building for conservation	O39-02
09:00	BOISSIERE Manuel - Forests, People, and the rest of the world: local participation in REDD+ Measuring, Reporting and Verification (PMRV)	O39-03
09:15	VALLARINO Barbara - Community-level Empowerment: How Social and Human Capital are the Drivers of Long-Term Conservation Success	O39-04

S43 | **Free session: Human-nature interactions in tropical landscapes**
Antigone 1 (Level 2)

08:30	VLAM Mart - Stable isotopes reveal the region of origin of tropical timber	O43-01
08:45	TELES Davi - Rationalising Amazonian conservation planning: opportunities of a watershed scale approach	O43-02
09:00	HAWES Joseph E. - Landscape-scale sustainability of Amazonian fisheries	O43-03
09:15	OJANGUREN Alfredo - Thermal ecology of an invasive tropical fish	O43-04

| **Free session**
Antigone 3 (Level 2)

| **Free session**
Rondelet (Level 2)

S50 | **Free session: Methods and metrics to evaluate and measure forest degradation**
Barthez (Level 2)
JANSEN Patrick, ROWCLIFFE Marcus, CARBONE Chris

08:30	GHAZOUL Jaboury - Defining forest degradation	O50-01
08:45	GRANADOS Alys - Experimental defaunation and habitat disturbance influence seed mortality but not seedling establishment	O50-02
09:00	FERRAZ Katia - Trophic ecology and functional diversity of terrestrial mammals at Atlantic Forest Hotspot	O50-03
09:15	BANDA Karina - Tree inventory data as a valuable tool for IUCN red list assessments	O50-04

09:30 - 10:00 Break (Level 1 & 2)

Program detailed

Wednesday 22 June 2016

10:00 **Symposia & Oral Sessions**

S31 | Next generation forest science, managing and restoring tropical forest genetic resources
Pasteur (Level 0 & 1)
TITO DE MORAIS Claire, KETTLE Christopher J., SCOTTI Ivan

10:00	HEUERTZ Myriam - Hybridization and the evolution of tropical tree species complexes	O31-05
10:15	JONES Frank - Comparative population genetics of tropical trees across a strong rainfall gradient: implications for species responses to climate change	O31-06
10:30	SHIMIZU Kentaro - Genome sequence and duplication of drought-responsive genes of a Southeast Asian dipterocarp, Shorea leprosula (Dipterocarpaceae)	O31-07
10:45	MARDEN James - Local population size, resistance gene diversity, and negative density dependence in tropical tree species	O31-08
11:00	TITO DE MORAIS Claire - Dipterocarp seedlings growth and mortality in natural forest: Importance of local pattern of genetic diversity and genetic relatedness for forest natural regeneration and conservation	O31-09
11:15	MONTHE KAMENI Franck - Extensive seed and pollen dispersal and assortative mating in the rainforest tree Entandrophragma cylindricum (Meliaceae) inferred from indirect and direct analyses	O31-10
11:30	ISMAIL Sascha - Welcome back! Genetic restoration of a tropical flagship tree species	O31-11
11:45	ODEE David - Genetic resource protection in neglected tropical forests: the value of dryland forest trees	O31-12

S34 | Free session: Tropical forest ecology, conservation and management
Einstein (Level 0)

10:00	BLANC Lilian - Conservation of tropical humid forest and wood supply in French Guiana: how sustainable forest plantation could help to respond to local demand in the future?	O34-01
10:15	GOOSEM Miriam - Hypothesis driven research of linear infrastructure impacts and mitigation solutions	O34-02
10:30	KORTE Lisa - Applying question-driven research to oil development practices in a tropical rainforest: a case study in Gabon	O34-03
10:45	MONRO Alex - Improving Carbon Stock Calculations in the Amazon: a case study from the Bolivia	O34-04
11:00	MUNOZ Johana - Effects of silvicultural intervention on natural regeneration of tropical mountain forest in southern ecuador	O34-05
11:15	NEGI Swati - Forest users' perceptions influencing community participation in community forests management : A case study of Nepal	O34-06
11:30	PIETSCH Stephan A. - Why history counts	O34-07
11:45	ROCKWELL Cara - Spatial distribution of Bertholletia excelsa in selectively logged forests of the Peruvian Amazon: Can historical disturbance explain juvenile spatial patterns?	O34-08

Wednesday 22 June 2016

S37 | Free session: Tropical ecology and society in African ecosystems

Sully 1 (Level 1)

10:00	DOUNIAS Edmond - Honeybees and honey gatherers: Co-sentinels of climate change in the Congo Basin	O37-01
10:15	CAMPBELL Heather - From elephants to ants: changes to ant assemblages caused by the impact of elephants in an African biodiversity hotspot	O37-02
10:30	DOUGHTY Chris - The role of large animals in distributing sodium through African forests	O37-03
10:45	YADOK Biplang - Uneven spatial density distribution of African pouched rats (Cricetomys spp) in a West African montane forest landscape	O37-04
11:00	MUKAKAMARI Dancilla - Promoting Indigenous Vegetables for Biodiversity Conservation and Sustainable Livelihoods Improvement in Rwanda	O37-05
11:15	SCHELLENBERGER Costa David - The abundant and the widespread – how do functional traits of dominant and broad-range species compare to overall trait space in trees, other terrestrial plants, and epiphytes?	O37-06
11:30	KEARSLEY Elizabeth - Rare tree species support functional diversity in resource-acquisition in central African forests	O37-07
11:45	TRANQUILLI Sandra - The critical status of protected areas in Africa	O37-08

S40 | Tropical tree structure and function: directions and gaps four decades after Hallé

Sully 3 (Level 1)

<u>SHENKIN Alexander</u>, HALLÉ Francis, MALHI Yadvinder

10:00	HALLÉ Francis - The Architecture of Tropical Trees	O40-01
10:15	STERCK Frank - New quantitative concepts on tree architecture and whole plant functioning	O40-02
10:30	BENTLEY Lisa Patrick - Exploring the scaling of tree branching architecture across the tropics	O40-03
10:45	SHENKIN Alexander - The shape of trees across the tropics: environmental and evolutionary roles in crown metabolic scaling	O40-04
11:00	MARTINEZ Isabel - Interspecific variation in tropical tree height and crown allometries in relation to life history traits	O40-05
11:15	CUSHMAN KC - Quantifying diurnal leaf movement and radiative transfer in tropical forests	O40-06
11:30	FAUSET Sophie - Light environments in intact and degraded Atlantic forests: from measurements to modelling	O40-07

Wednesday 22 June 2016

S43 | Free session: Human-nature interactions in tropical landscapes

Antigone 1 (Level 2)

10:00	BENHAM Claudia - Putting transdisciplinary research into practice: a participatory approach to understanding change in tropical social-ecological systems	O43-05
10:15	JAMES Moloney - 'Conservation' versus clearance: Land-use conflicts in North eastern Thailand	O43-06
10:30	WANGPAKAPATTANAWONG Prasit - Plant Usages of Lowland and Lawa Populations in Phu Fah Subdistrict, Bo Klua District, Nan Province, Thailand	O43-07
10:45	LU Pei-Luen - Biodiversity of Long Lellang and Sustainability of Borneo Indigenous Community Initiative by the Nature Appreciation Rainforest School, Sarawak, Malaysia	O43-08
11:00	PARDINI Renata - Disturbance or propagule pressure? Unraveling the drivers of the invasion of free-ranging dogs in Atlantic forest landscapes	O43-09
11:15	PONTA Nicole - How do indigenous hunters of the Colombian Amazon resolve trade-offs between conservation and development?	O43-10
11:30	ROCHA Juliana - What affects the occurrence of the golden-headed lion tamarin, Leontopithecus chrysomelas, in Brazilian cocoa agroforests?	O43-11
11:45	SUNDERLAND Terence - Agrarian Change in Tropical Landscapes – A Change for the Better?	O43-12

S45 | Biodiversity patterns and processes along altitudinal gradients in tropical forests

Antigone 3 (Level 2)

GONMADJE Christelle, FLORES Olivier, DOUMENGE Charles

10:00	BERZAGHI Fabio - Comparative niche modeling of bush-shrikes along an elevational gradient highlights the plight of mid-elevation forests	O45-01
10:15	FARWIG Nina - Benefits of remotely sensed data for biodiversity mapping along an elevational gradient in a mountain rainforest system	O45-02
10:30	BRUY David - Abundance, richness and composition of lianas community along an altitudinal gradient in New-Caledonia	O45-03
10:45	FINEGAN Bryan - Do the foliar functional properties of liana assemblages differ from those of the trees they share the forest canopy with? A test on a rain forest altitudinal gradient in Costa Rica	O45-04
11:00	GONMADJE Christelle - Altitudinal gradients of tree species diversity and above-ground biomass on a small montane of Atlantic Central Africa	O45-05
11:15	SALGADO Jhenny - Variation in fine root biomass and production after continued nutrient addition to Andean forests	O45-06
11:30	CUNI-SANCHEZ Aida - Could carbon save tropical montane forests in Africa?	O45-07
11:45	SAM Legi - Host–plant translocations and novel plant–insect interactions along an elevational gradient in Papua New Guinea	O45-08

Wednesday 22 June 2016

S47 | Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration
Rondelet (Level 2)
BUISSON Elise

10:00	VELDMAN Joseph - Old-growth savannas and tropical ecosystem degradation	O47-01
10:15	DO ESPÍRITO-SANTO Mário - Drivers of land-cover change and their welfare consequences in the Brazilian Cerrado	O47-02
10:30	DURIGAN Giselda - The need of fire for conservation and restoration of Cerrado grasslands	O47-03
10:45	HOLMGREN Milena - Tree expansion in subtropical South American grasslands	O47-04
11:00	BUISSON Elise - Campos rupestres, a neglected conservation priority	O47-05
11:15	COSTA Fernanda - Temperature and resource type shape ant-plant interactions in Brazilian rocky grasslands	O47-06
11:30	MAHY Gregory - Challenges in extreme tropical grasslands	O47-07
11:45	BOISSON Sylvain - Using phytostabilisation as a way to conserve threatened endemic species from the Southeastern D.R. Congo	O47-08

S51 | Pattern and process in tropical mammal communities: a camera trapping perspective
Barthez (Level 2)
JANSEN Patrick, ROWCLIFFE Marcus, CARBONE Chris

10:00	JANSEN Patrick - Camera trapping of tropical mammal communities: introduction to the symposium	O51-01
10:15	FALCONI Nereyda - Activity of terrestrial mammals in the Tamshiyacu Tahuayo communal reserve, northeastern Peru	O51-02
10:30	CARBONE Christopher - Body size scaling of photographic detection and its implications for biodiversity surveys	O51-03
10:45	XAVIER DA SILVA Marina - Effectiveness of Protected Areas for biodiversity conservation: mammal occupancy patterns in the Iguaçu National Park	O51-04
11:00	PENIDO Gabriel - The importance of considering more than one variable group in occupancy analyses: a case study	O51-05
11:15	AHUMADA Jorge - Temporal sensitivity of the Wildlife Picture Index as an indicator for changes in communities of ground-dwelling terrestrial vertebrates sampled with camera traps	O51-06
11:30	ROWCLIFFE Marcus - Random encounter modelling for multi-species density estimation from single camera surveys	O51-07
11:45	WEARN Oliver - Multi-species modelling using camera traps: challenges and opportunities	O51-08

12:00 - 13:30 Lunch & Lunch Sessions (Level 3)

13:30 **Plenary Sessions 5** *Pasteur (Level 0 & 1)*
Marielos PENA-CLAROS, Associate Professor, Wageningen University
Conserving tropical forests: the potential role of sustainable forest management

Wednesday 22 June 2016

14:30 SYMPOSIA & ORAL SESSIONS

S32 | Europe's role in driving the future of tropical forested landscapes

Pasteur (Level 0 & 1)
GHAZOUL Jaboury

14:30	KARSENTY Alain - Europe, environmental norms and incentives	O32-01
14:45	MESSERLI Peter - Globalised drivers of land use changes on tropical forest frontiers: the concept of 'telecoupling' and its operationalisation in land system science	O32-02
15:00	GAZULL Laurent - Europe is ruling the new global wood-energy market: what potential impact on Central African forest sector ?	O32-03
15:15	NGOM Emmanuel Pierre Jonathan - Reconciling Conservation and Development: The case of oil palm in Cameroon	O32-04

S34 | Free session: Tropical forest ecology, conservation and management

Einstein (Level 0)

14:30	SORIANO Marlene - Fate of Bertholletia excelsa populations under reduced-impact logging and Amazon nuts gathering: a multiple use forest management perspective	O34-09
14:45	RÖDIG Edna - Differences of productivity in the Amazon rainforest: estimates with an individual-based forest gap model	O34-10
15:00	TAUBERT Franziska - The structure of tropical forests and sphere packings	O34-11
15:15	WAGNER Fabien Wagner - Climate seasonality limits leaf carbon assimilation and wood carbon storage in tropical forests	O34-12

S38 | A brave new world: integrating wellbeing and justice in conservation

Sully 1 (Level 1)
GROSS-CAMP Nicole, BIEDENWEG Kelly, WOODHOUSE Emily, BURGESS Neil

14:30	BIEDENWEG Kelly - Developing and implementing a human wellbeing framework for conservation planning	O38-01
14:45	STERLING ELEANOR - Measuring biocultural interactions and dynamics for sustainable resource management	O38-02
15:00	BOURONCLE Claudia - Community forestry projects and the strengthening of capabilities and agency in the Oxapampa-Ashaninka-Yanesha Biosphere Reserve, Peru	O38-03
15:15	GROSS-CAMP Nicole - Does community-based forest management improve wellbeing in Tanzania?	O38-04

S41 | Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned

Sully 3 (Level 1)
LOHMANN Lúcia, MWAMPAMBA Tuyeni, BALVANERA Patricia

14:30	BALVANERA Patricia - Distributed Graduate Seminar in Sustainability Science: Cross-cultural Learning with a Low Carbon Footprint	O41-01
14:45	LAKSHMI Charli-Joseph - Using the case-study approach for sustainability education: The example of socio-hydrological risk in Mexico City	O41-02

Wednesday 22 June 2016

15:00		RIENSCHE Marion - Using case studies to teach synthesis and analysis of complex sustainability challenges	O41-03
15:15		SANTOS Maria J - Teaching sustainability science from a systems analysis perspective: MSc course at Utrecht University	O41-04

S44 | Free session: Secondary forest succession and restoration
Antigone 1 (Level 2)

14:30	CHAZDON Robin - A spatially explicit model of natural regeneration potential: a case study from the Piracicaba River Basin, Brazil	O44-01
14:45	BREARLEY Francis - Secondary succession in forests of central Borneo: a 19-year record	O44-02
15:00	BRADFER-LAWRENCE Tom - Bird community development in the canopy and understorey of Neotropical secondary forest	O44-03
15:15	MAYHEW Rebekah - Characterising avian communities across a successional gradient in regenerating tropical forests of Central Panama	O44-04

S45 | Biodiversity patterns and processes along altitudinal gradients in tropical forests
Antigone 3 (Level 2)
GONMADJE Christelle, FLORES Olivier, DOUMENGE Charles

14:30	GONZALEZ Mailyn - Taxonomic, functional and phylogenetic diversity of birds in highly threatened ecosystems of the Colombian Andes	O45-09
14:45	SAM Katerina - Ecology of birds along an elevational gradient and their predation pressure on arthropods	O45-10
15:00	WARDHAUGH Carl - Elevational changes in the structure of beetle assemblages in the tropical rainforests of northern Australia and Papua New Guinea	O45-11
15:15	JACQUEMIN Justine - Trophic ecology of ants and spiders along a wide elevational gradient in Papua New Guinea revealed by stable isotopes	O45-12

S48 | Free session: Ecology and conservation of tropical soils
Rondelet (Level 2)

14:30	HICKS Lettice - Litter traits modulate the effect of temperature on decomposition along a tropical elevation gradient in the Peruvian Andes	O48-01
14:45	MANNING Frances - Root respiration drives patterns of total soil CO2 from cultivated tropical peatlands	O48-02
15:00	LASSO Eloisa - Abrupt, non-linear responses of soil heterotrophic respiration (RH) to intense climatic fluctuations may result in rapid losses of soil organic carbon in tropical high elevation ecosystems (Páramos)	O48-03
15:15	ZUQUIM Gabriela - Mapping soil conditions from fern occurrences in Amazonia	O48-04

Wednesday 22 June 2016

S52 Part 1 | Free session: Tropical ecology
Barthez (Level 2)

14:30	PUYRAVAUD Jean-Philippe - Landscape connectivity for the Asian elephant in its largest remaining subpopulation and regional planning	O52-01
14:45	ASTETE Samuel - Forced neighbors: co-existence between jaguars and pumas in the semi-arid Caatinga biome of Brazil	O52-02
15:00	CARTRÓ-SABATÉ Mar - Identifying sources of lead in Amazonian wildlife by lead isotope analysis	O52-03
15:15	VRIESENDORP Corine - Rapid Inventories, Museum Science, and Conservation in Loreto, Peru	O52-04

15:30 - 16:00 Break (Level 1 & 2)

16:00 Symposia & Oral Sessions

S32 | Europe's role in driving the future of tropical forested landscapes
Pasteur (Level 0 & 1)
GHAZOUL Jaboury

16:00	CARLSON Kimberly - Impact of Roundtable on Sustainable Palm Oil certification on deforestation and fire in Indonesia	O32-05
16:15	VIRAH-SAWMY Malika - Cost, benefit and impacts of palm oil production: a cross-scale actor analysis	O32-06
16:30	QUÉTIER Fabien - No net loss of biodiversity? Mitigating development impacts and the future of tropical forested landscapes	O32-07
16:45	GOODMAN Lael K. - The role of commodities in tropical deforestation	O32-08
17:00	AN KUIJK Marijke - Sustainable production as the new standard, but we need convincing evidence.	O32-09
17:15	VERBURG René - Is certification the silver bullet to promote sustainable production of tropical commodities?	O32-10

S35 | Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future
Einstein (Level 0)
MUNOZ François, DAVIDAR Priya

16:00	BOSE Ruksan - Influence of past and present environmental heterogeneity on the ecology and biogeography of Western Ghats endemic tree species	O35-01
16:15	RAY Avik - Indian Myrtaceae refutes 'out-of-India' hypothesis however resurrects the Gondwana antiquity	O35-02
16:30	DAYANANDAN Selvadurai - Phylogenetic and molecular dating analyses of endemic trees to gain insights into the evolution of biodiversity in the Western Ghats-Sri Lanka biodiversity hotspot	O35-03
16:45	PARTHASARATHY Narayanaswamy - Patterns of liana diversity in different forest types of the Western Ghats biodiversity hotspot	O35-04
17:00	GUNATILLEKE Nimal - South-west Sri Lanka: a floristic refugium in South Asia	O35-05
17:15	DAVIDAR Priya - Are montane shola forest trees ecologically distinctive among Western Ghats tree flora?	O35-06

Program detailed

Wednesday 22 June 2016

S38 | A brave new world: integrating wellbeing and justice in conservation
Sully 1 (Level 1)
GROSS-CAMP Nicole, BIEDENWEG Kelly, WOODHOUSE Emily, BURGESS Neil

16:00	RODRIGUEZ Iokiñe - Linking wellbeing with cultural-identity building for greater cognitive justice in conservation: lessons from Venezuela in Canaima National Park	O38-05
16:15	TALLMAN Paula - Wellbeing and conservation: Can humans and forests thrive together?	O38-06
16:30	ANAYA Felisa - Conservation units and territorial exclusion of traditional peoples: analyzing the social impacts of environmental compensation strategies in Brazil	O38-07
16:45	NADIRUZZAMAN Md - Post-Sidr Scenario and Forest Conservation in the Sundarbans: Whose Knowledge Counts?	O38-08
17:00	DUCHELLE Amy - Using local-level data to monitor REDD+ social safeguards: Evidence from 6 countries	O38-09
17:15	CRANSTON Kayla A. - The psychology of human wellbeing as a predictor of long-term capacity for conservation	O38-10

S42 | Developing research capacity on biodiversity and conservation: a caribbean challenge
Sully 3 (Level 1)
CEZILLY Frank

16:00	CÉZILLY Frank - Developing research capacity in biological conservation and wild life management: a Caribbean perspective	O42-01
16:15	MATHER-L'HUILLIER Nathalie - Developing training in veterinary sciences and conservation medicine in the Caribbean: the case of Ross University School of Veterinary Medicine in St. Kitts	O42-02
16:30	VALLÈS Henri - The University of the West Indies: building research capacity for biodiversity conservation in the Caribbean	O42-03
16:45	VIERA FRAGOSO José Manuel - Integrating Tertiary Education on Biodiversity Conservation with Island Needs.	O42-04
17:00	IMBERT Daniel - The ECOTROP Master's degree of the Université des Antilles: a tool for promoting biodiversity conservation in the Caribbean	O42-05
17:15	GROS-DÉSORMEAUX Jean-Raphaël - Developing cooperation capacity in biodiversity conservation: the French West Indies (FWI) territories perspectives	O42-06

S44 | Free session: Secondary forest succession and restoration
Antigone 1 (Level 2)

16:00	MARTINEZ-GARZA Cristina - Performance of eight years old restoration plantings at a Mexican tropical dry forest	O44-05
16:15	LACHLAN Charles - Factors affecting seed rain under remnant pasture trees: A Pan-Tropical study	O44-06
16:30	MONRO Alex - Adapting Inga-based agroforest to the Bolivian Amazon	O44-07
16:45	OSTERTAG Rebecca - Evaluating novel species mixtures in a functional trait-based restoration experiment	O44-08
17:00	PALMA Ana - Direct seeding and planting of seedlings in secondary forests: the roles of dispersal and recruitment limitations	O44-09
17:15	WERDEN Leland - Using plant functional traits and soil amendments to restore degraded vertisol soils in a tropical dry forest	O44-10

Wednesday 22 June 2016

S46 | Free session: Climate change in tropical ecosystems
Antigone 3 (Level 2)

16:00	DUNN Christopher - Impacts of climate change on indigenous communities: role of botanic gardens in biocultural conservation	O46-01
16:15	MARGROVE James - Micro-topographic variation and water abundance create heterogeneous landscapes for dipterocarp seedlings on alluvial plains	O46-02
16:30	MARTÍNEZ-RAMOS Miguel - Long-term forest dynamics in a Neotropical tropical rainforest landscape: assessing possible global warming sings	O46-03
16:45	MENGER Juliana - Environment and landscape features drive changes in Amazonian forest bird assemblages	O46-04
17:00	OTERO Luisa - Operative temperatures and stress response in Puerto Rican Anolis lizards	O46-05
17:15	PAZ Andrea - Differential response of Andean frogs by elevational range to Pleistocene climate change inferred form a distribution modeling analysis	O46-06

S49 | Fire and biodiversity in the tropics: contrasting savannas and forests
Rondelet (Level 2)
CAMPOS Ricardo, VASCONCELOS Heraldo

16:00	PARR Kate - Testing the link between pyrodiversity and biodiversity across African savannas	O49-01
16:15	NEVES Frederico - Effect of fire on insect interactions in tropical megadiverse mountains	O49-02
16:30	VASCONCELOS Heraldo - A meta-analysis of the effects of fire disturbance on ant abundance and diversity	O49-03
16:45	CAMPOS Ricardo - Impacts of fire and fuel loads on ant community structure and their interactions with seeds in Amazonian rainforest	O49-04
17:00	M. FLORES Bernardo - Drought-driven fires and resilience of Amazonian floodplain forests	O49-05
17:15	VIEIRA Emerson - Fire occurrence mediates small-rodent seed removal in neotropical gallery forests inside savanna habitats	O49-06

S52 Part 1 | Free session: Tropical ecology
Barthez (Level 2)

16:00	ZALAMEA Paul-Camilo - Physical and chemical defenses in tropical pioneer seeds: trade-offs and seed defense syndromes	O52-05
16:15	SERRANO Julieth - Biotic homogeneity of biogeographic units in the Neotropics: a test with Sapotaceae	O52-06
16:30	SCHULZE Christian H. - Behavioral response of flower-visiting hummingbirds to sit-and-wait predators	O52-07
16:45	FEENER Jr. Donald H. - Oviposition Behavior of Phorid Parasitoids Attacking Carpenter Ants in the Genus Camponotus	O52-08
17:00	VERBEECK Hans - Introducing tropical liana proliferation in a vegetation model	O52-09
17:15	DENIS Thomas - What is the relative importance of physical, biological environment and geographic distance in shaping medium and large fauna assemblages in lowland Amazonia?	O52-10

17:30 **Poster Sessions** *Poster Area (Level 1)*

18:30 **Photo Conference** *Pasteur (Level 0 & 1)*

Program detailed

Thursday 23 June 2016

08:00 **Symposia, Oral Sessions & Free Sessions** *Pasteur (Level 0 & 1)*

S53 | Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation

Pasteur (Level 0 & 1)

RAZAFINDRATSIMA Onja, GANZHORN Joerg, CARRIERE Stephanie

08:00	WRIGHT Patricia - The challenges and opportunities of conservation in Madagascar	
08:30	NOPPER Joachim - Long-term monitoring for adaptive ecosystem management in south-western Madagascar	O53-01
08:45	STOUDMANN Natasha - Dissecting change: Assessing farmers' perceptions and strategies in Madagascar	O53-02
09:00	RANJATSON Patrick - The original interactions between actors in natural resources tenure rights in Antanandava, Madagascar: the household, the family and the State	O53-03
09:15	RAKOTO RATSIMBA Harifidy - Observing changes at watershed scale: tracking spatial organization of land-use in the Alaotra Mangoro, Madagascar	O53-04
09:30	ZOSSO Cyrill - Marshland management in the Alaotra region (Madagascar) – Discussing preferences with local stakeholders on the basis of a role-playing game	O53-05
09:45	WILMÉ Lucienne - Rice or lemurs, or rice and lemurs? A case study from the wetlands of the Alaotra, Madagascar	O53-06

S55 | Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome

Einstein (Level 0)

CORNELIS Daniel, LE BEL Sébastien, VERMEULEN Cédric

08:00	FA John E. - Space for Hunting: Understanding Indigenous and other Hunters' Impacts in the Congo Basin Forests	O55-01
08:15	GAIDET Nicolas - Hunting practices as drivers of small- and large-scale spatial variations in wildlife occurrence: an inter-site comparison across Central Africa	O55-02
08:30	WILKIE David - Bushmeat Hunting Risks Driving Large-bodied Animals to Extinction	O55-03
08:45	LESCUYER Guillaume - Financial and economic values of bushmeat in rural and urban livelihoods in Cameroon: Inputs to the development of public policy	O55-04
09:00	BOUTINOT Laurence - The protection of traditional knowledge and subsistence rights of indigenous people and local communities	O55-05
09:15	LINDSEY Peter - The economic and food security impacts of the illegal bushmeat trade in African savannahs	O55-06
09:30	LE BEL Sébastien - New technologies: mobile data collection system implication for wildlife management in Central Africa	O55-07
09:45	CZUDEK Rene - community commercial conservancies as a valuable land use option in Southern Africa	O55-08

Thursday 23 June 2016

S57 | Intraspecific variation in tropical trees - implication for tropical forest responses to global change

Sully 1 (Level 1)

COMITA Liza, ENGELBRECHT Bettina, JONES F. Andrew

08:00	VIOLLE Cyrille - Species coexistence, inter- and intraspsecific trait variation in a tropical forest	O57-01
08:05	UMANA Maria Natalia - Variation in allocation vs. organ level traits in tropical seedling communities in tropical China and Puerto Rico	O57-02
08:10	SUN I Fang - Disentangling different sources of intraspecific functional trait variation in a subtropical rain forest	O57-03
08:15	FORTUNEL Claire - Evaluating the contribution of ontogeny to intraspecific variability in functional traits of tropical trees	O57-04
08:20	CAVALERI Molly - Is within-canopy variation of leaf functional traits more important than intraspecific variation in tropical forest canopies?	O57-05
08:25	ROWLAND Lucy - Does intra-specific variation prevent division of tropical trees into drought sensitive and resistant groups?	O57-06
08:30	ENGELBRECHT Bettina - Intraspecific variation of seedling drought resistance across a strong rainfall gradient at the Isthmus of Panama	O57-07
08:35	HIETZ Peter - Intra- and interspecific variation in wood functional traits of tropical trees	O57-08
08:40	FADRIQUE Belen - Let the botanical gardens be functional	O57-09
08:45	SCOTTI Ivan - Microgeographic adaptation in tree stands	O57-10
08:50	STACY Elizabeth - Insights into the adaptability of tropical trees from Hawaii's landscape dominant, Metrosideros polymorpha	O57-11
08:55	BROUSSEAU Louise - Local adaptation to microgeographic habitat patchiness in Amazonian trees: example of the hyperdominant Eperua falcata (Aubl.)	O57-12
09:00	HARDY Olivier - Intra-specific variation in African tropical trees : molecular and phenotypic evidences	O57-13
09:05	BLATRIX Rumsais - Strong spatial genetic structure is correlated with climatic niche in a tree of the African tropical rain forest	O57-14
09:10	KRAFT Nathan - Are tropical tree habitat specialists less variable in key functional traits than habitat generalists?	O57-15
09:15	CHACON Eduardo - Intra-specific variation in functional traits between narrow endemic and widespread tropical trees	O57-16
09:20	KETTLE Chris - From Fragmentation Genetic to Genomics and Back	O57-17

Thursday 23 June 2016

S60 | Introduction: A. Pietsch
Management impacts on biodiversity and carbon/nutrient balances in the tropics
Sully 3 (Level 1)
PIETSCH Stephan, PENUELAS Josep, CIAIS Philippe, JANSSENS Ivan, OBERTSEINER Michael

08:00	PIETSCH Stephan, PENUELAS Josep, CIAIS Philippe, JANSSENS Ivan, OBERTSEINER Michael Introduction	
08:30	GRAU Oriol - The role of soil characteristics on forest structure and dynamics in extremely poor tropical soils	O60-01
08:45	INAGAWA Takeshi - Nutrient uptake, resorption and allocation along a disturbance gradient in Bornean tropical forests	O60-02
09:00	SCHIER Franziska - Long-term recovery dynamics in a natural regeneration forest	O60-03
09:15	VAN DER SANDE Masha - Biodiversity effects on forest functioning across spatial and temporal scales	O60-04
09:30	NESPER Maike - Changing coffee agroforestry in the Western Ghats: loss of biodiversity and ecosystem services through intensification in Kodagu, South India	O60-05
09:45	CHANG Jinfeng - Historic carbon the GHG balances of tropical grassland from 1901 to 2010	O60-06

S62 | Disrupted species interactions and cascade effects in human-modified landscapes
Antigone 1 (Level 2)
TABARELLI Marcelo, LEAL Inara

08:00	CORDEIRO Norbert - The tragedy of losing good leaders: observational and experimental evidence of disintegrating mixed species bird flocks in a fragmented African biosphere reserve	O62-01
08:15	FARIA Deborah - Multiple drivers influencing tree regeneration in human-modified landscapes of Atlantic forest	O62-02
08:30	NEUSCHULZ Eike Lena - A global assessment of forest disturbance on plant regeneration: the crucial role of pollinators and seed dispersers	O62-03
08:45	QUESADA Mauricio - Pollination ecosystem services in the interface of natural-human modified environments of a neotropical dry forest	O62-04
09:00	KORMANN Urs - Corridors are pollination highways in tropical fragmented landscapes	O62-05
09:15	EMER Carine - Multiple drivers of anthropogenic disturbance affect the structure of plant-frugivore networks	O62-06
09:30	LEAL Inara - Anthropogenic disturbance and climate change reduce seed dispersal and anti-herbivore protection services provided by ants to plants	O62-07
09:45	METZGER Jean Paul - Relationships among Landscape Structure, Ecological Processes, Biodiversity and Ecosystem Services – Interface Project	O62-08

Thursday 23 June 2016

S64 | Towards an unified vision of the central african forests

Antigone 3 (Level 2)

GOURLET-FLEURY Sylvie, FAYOLLE Adeline, PELISSIER Raphaël

08:00	LINDER H. Peter - The vegetation of Central Africa : a biogeographical perspective	O64-01
08:15	DAUBY Gilles - Phytogeography, (phylo)diversity and threatened species of tropical Africa: new insights from a mega database on the distribution of tropical African vascular plants	O64-02
08:30	FAYOLLE Adeline - Patterns of tree species composition across tropical African forests and within central African moist forests: the need for adapted management and conservation strategies	O64-03
08:45	LIBALAH Moses - Complementarity of environmental factors explain spatial floristic variations in mixed lowland rainforest of Cameroon	O64-04
09:00	RÉJOU-MÉCHAIN Maxime - Can we predict forest composition across space and time in Central Africa	O64-05
09:15	BASTIN Jean-Francois - Functional shifts within Central African rainforests	O64-06
09:30	GARCIA Claude - Gateway to the Forests of Central Africa : towards a unified collaborative model of forest dynamics	O64-07
09:45	DE GRAVE Arnaud - Ethnophotography of Sciences: using photography to foster transdisciplinarity in the forest landscapes of Cameroon	O64-08

S67 | Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation

Rondelet (Level 2)

LEHMANN Caroline, PARR Catherine

08:00	VORONTSOVA Maria S. - Using the knowledge of endemic grass species to puzzle out ancient Madagascar	O67-01
08:15	STEVENS Nicola - Woody encroachment over 70 years in South African savannas: overgrazing, global change or extinction aftershock?	O67-02
08:30	ARCHIBALD Sally - Competing Consumers: contrasting the patterns and impacts of fire and herbivory	O67-03
08:45	HEMPSON Gareth - Changes in African herbivore communities and consequences for grassy ecosystems	O67-04
09:00	OLIVERAS Imma - Many shades of green: the dynamic tropical forest-savanna transitions	O67-05
09:15	ALEMAN Julie - Redefining the historical forest extent in Sub-Saharan Africa: implications for grass-dominated biomes conservation	O67-06
09:30	ESTES Lyndon - Reconciling agriculture, carbon, and biodiversity in a savanna transformation frontier	O67-07
09:45	LAYME Viviane - Population Dynamics of three rodent species in a Flooded Neotropical Savanna	O67-08

Program detailed

Thursday 23 June 2016

S70 | **Systems view of agro-ecological landscapes**
Barthez (Level 2)
MOREL Alexandra, HIRONS Mark, NORRIS Ken

08:00	MOREL Alexandra - The limits of ecosystem services from forest to small-scale cocoa and coffee yields in Ghana and Ethiopia	O70-01
08:15	WANGER Thomas Cherico - Pollination and pest control in cocoa agroforestry landscapes	O70-02
08:30	PAVAGEAU Charlotte - Connectivity modelling of pollination services in a tropical landscape	O70-03
08:45	FAYE Emile - Multi-scale approach of crop microclimates in complex agro-ecological landscapes in Ecuador: towards new pest management strategies?	O70-04
09:00	BOS Swen - Local Knowledge and Boundary Objects: Understanding the underlying drivers of change in a upland socio-ecological system to better resolve the conservation and development trade-off	O70-05
09:15	RAVAKA Annick - Understanding farmers: using role playing games to track landscape trajectories	O70-06
09:30	MAAS Bea - Pest predation services of birds and bats in tropical forests and agroforestry landscapes	O70-07
09:45	HIRONS Mark - Multi-dimensional poverty and tree crops in African agroforest systems	O70-08

10:00 - 10:30 Break (Level 1 & 2)

10:30 Symposia

S53 | **Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation**
Pasteur (Level 0 & 1)
RAZAFINDRATSIMA Onja, GANZHORN Joerg,CARRIERE Stephanie

09:30	RAFIDISON Verohanitra M. - Cultural values of Ficus in agrarian territories for the Betsileo (Madagascar) and their impacts on biodiversity conservation	O53-07
09:45	GILLESPIE Thomas - Effective Integration of Human Healthcare and Ecosystem Conservation for the Greater Ranomafana Ecosystem, Madagascar	O53-08
10:30	GAY-DES-COMBES Justine - Selective slashing coupled with compost amendment can lead to a sustainable slash and burn agricultural system in Madagascar	O53-09
10:45	DILLMANN Céline - If soil fertility is not the problem, compost is not the solution	O53-10
11:00	RAMAMONJISOA Bruno Salomon - Understanding change and stakeholders engagement to improve natural resources management, a case study from Madagascar	O53-11
11:15	ANDRIAMARO Luciano - Strengthen marine biodiversity conservation through community-based approach in Ambodivahibe protected area	O53-12

S55 | **Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome**
Einstein (Level 0)
CORNELIS Daniel, LE BEL Sébastien,VERMEULEN Cédric

10:30 GAMES

Thursday 23 June 2016

S58 | Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing
Sully 1 (Level 1)
GOND Valery, HELMER Eileen

10:30	HELMER Eileen H. - Projections of the future distributions of páramo and subalpine Neotropical forests from satellite image interpretation and climate data	O58-01
10:45	LE CLEC'H Solen - Mapping ecosystem services at the regional scale: the contribution of an up-scaling approach. The case of the Amazon pioneer front	O58-02
11:00	PARGAL Sourabh - Characterizing texture- structure relationship in the tropical forests of Western Ghats of India using high resolution Cartosat Imagery	O58-03
11:15	SCHMID Tobias - Understanding changes in the landscape based on a Landsat remote sensing analysis in the Karbi Anglong hills, Assam, India	O58-04
11:30	VERHEGGHEN Astrid - Analysis of the potential of 10m resolution optical imagery for the monitoring of logging impacts on the forest cover in the Republic of Congo	O58-05
11:45	VIEILLEDENT Ghislain - Bioclimatic envelope models predict a decrease in tropical forest carbon stocks with climate change in Madagascar	O58-06

S61 | Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics
Sully 3 (Level 1)
CALMÉ Sophie, WHITE Rehema, LÉCUYER Lou

10:30	CALMÉ Sophie - Introduction - Biodiversity impact is not biodiversity conflict	O61-01
10:45	DAIN Jonathan - Poisoned birds and four slashed tires: Building capacity to manage biodiversity conflict in South America	O61-02
11:00	LECUYER Marie-Lou - Why might actors perceive environmental management as being unfair? Understanding constructions of justice appraisal in the case of jaguar management in Calakmul, Mexico	O61-03
11:15	KIMMEL Lynn - Conservation conflict transformation in action: addressing conflict dynamics affecting the endangered Grevy's zebra in Kenya	O61-04
11:30	MUSGRAVE Michael - Biology is (almost) irrelevant. Governance is (almost) everything for successful biodiversity conservation outcomes in Africa	O61-05
11:45	WHITE Rehema - What is the role of biologists in biodiversity conflicts? An interactive debate exploring routes to sustainability	O61-06

S62 | Disrupted species interactions and cascade effects in human-modified landscapes
Antigone 1 (Level 2)
TABARELLI Marcelo, LEAL Inara

10:30	OLAYA-ARENAS Paola - Impact of agrochemicals on native plant-insect interactions along unmanaged crop borders	O62-09
10:45	WIRTH Rainer - The neglected response/role of leaf-cutting ants in chronically disturbed dry tropical forests	O62-10
11:00	PEDROSA Felipe - Ecological consequences of feral pig (Sus scrofa) invasion in the Atlantic Forest	O62-11
11:15	TSCHAPKA Marco - Host-specific traits as drivers of virus infections in Neotropical bats and rodents	O62-12

Thursday 23 June 2016

S65 | Subsistence hunting in the tropics: A coupled human natural system perspective

Antigone 3 (Level 2)

FRAGOSO Jose (Joe) Manuel V., SILVIUS Kirsten Mariana

10:30 SILVIUS Kirsten - Modeling sustainability in multiple use protected areas: hunting, food security, and land use change O65-01

10:45 VAN VLIET Nathalie - Untangling the legal path for the sustainable use and trade of wildmeat by rural communities in Colombia O65-02

11:00 RICHARD-HANSEN Cécile - Developing locally adapted hunting management regulations for French Guiana O65-03

11:15 COAD Lauren - Patterns of wild meat consumption in Central Africa O65-04

11:30 SINGH Michele - Legalized hunting on the Neotropical Island of Trinidad, West. Indies: A fifteen year study of hunting permits and harvest data O65-05

11:45 VIEIRA Marina A. R. M. - Interactions between institutional systems of hunting regulations in a Protected Area in the Brazilian Amazon O65-06

S68 | Is habitat fragmentation driving tropical forests towards functional homogenization?

Rondelet (Level 2)

ZAMBRANO Jenny, BECKMAN Noelle, FORTUNEL Claire, GARZON Carol,

10:30 ZAMBRANO Jenny - Is forest fragmentation driving functional homogenization in remaining tropical forest fragments? O68-01

10:45 TABARELLI Marcelo - Reorganization of tropical tree assemblages in human-modified landscapes: patterns, driving forces and potential impacts O68-02

11:00 BRUNA Emilio - Does habitat fragmentation dampen or amplify demographic heterogeneity? O68-03

11:15 DENT Daisy - Persistence of forest tree species in human-modified landscapes of central Panama O68-04

11:30 BARALOTO Christopher - Roads, fragmentation and the functional composition of southwestern Amazonian forests O68-05

11:45 BENITEZ-MALVIDO Julieta - Matrix type influences tree community assemblages along tropical dry forest edges O68-06

S71 | Functional traits in tropical agroecology

Barthez (Level 2)

MARNEY Isaac, ADAM Martin

10:30 WOOD Stephen - Applying approaches from functional biodiversity to understand agriculture, nutrition, and environment O71-01

10:45 LOHBECK Madelon - Functional ecology as a framework for restoring degraded human-modified landscapes in East Africa O71-02

11:00 ESQUIVEL SHEIK M. Jimena - Adult tree abundances and plant traits can help predict tree species' natural regeneration and delivery of ecosystems services in agricultural landscapes O71-03

11:15 TAUGOURDEAU Simon - Can functional traits explain the dynamic of undesirable species in tropical grasslands? O71-04

11:30 SAJ Stephane - Effect of simplification/complexification on functional features of associated trees community in cocoa based agroforestry systems O71-05

11:45 MARTIN Adam - Functional trait-based agroecology: progress and prospects for quantifying trait variation in crops O71-06

Thursday 23 June 2016

12.00 - 13.30 Lunch & Lunch Sessions (Level 3)

13:30 **Plenary Sessions 6** *Pasteur (Level 0 & 1)*

Tuyeni MWAMPAMBA, Researcher, UNAM-CIEco

The future role and key challenges of biodiversity conservation and use in Africa

14:30 Symposia, Oral Sessions & Free Sessions

S54 | Applying the nexus approach to understand tradeoffs and synergies between c harcoal, food and water production in tropical forests

Pasteur (Level 0 & 1)

MWAMPAMBA Tuyeni, GHILARDI Adrian

14:30 BAILIS Robert - Justification for an energy-food-water nexus approach in charcoal production systems: Introduction to the Symposium topic O54-01

14:45 OWEN Matthew - Barriers to legally compliant charcoal production by large landowners in Kenya O54-02

15:00 HOFFMANN Harry - At the wooden cross-road: Transforming the vicious cycle of unsustainable charcoal production into a virtuous cycle of increased producer's resilience in Sub-Saharan Africa O54-03

15:15 KARLBERG Louise - Tackling complexity in a changing climate: the role of charcoal in relation to energy transitions and agricultural transformations in low income countries O54-04

S56 | Towards refined carbon budgets of managed forests

Einstein (Level 0)

RUTISHAUSER Ervan, SIST Plinio, HÉRAULT Bruno

14:30 HERAULT Bruno - What is the carbon balance of tropical managed forests? O56-01

14:45 RUTISHAUSER Ervan - Effects of logging on forest stand carbon recovery and tree biomass O56-02

15:00 PIPONIOT-LAROCHE Camille - Modelling aboveground biomass dynamics in Amazonian selectively logged forests O56-03

15:15 ROZAK Andes - Deadwood in logged-over Dipterocarp forests of Borneo O56-04

S59 | Mapping and monitoring tropical forest degradation with remote sensing

Sully 1 (Level 1)

GOND Valery, BLANC Lilian

14:30 VANCUTSEM Christelle - Mapping intact and disturbed humid forests over the tropical belt from 32 years of Landsat time series O59-01

14:45 POTTS Matthew - 42 years of tree cover loss and gain in Southeast Sulawesi, Indonesia O59-02

15:00 HUTH Andreas - Carbon losses due to tropical forest fragmentation: a forgotten process in the global carbon cycle? O59-03

15:15 TRITSCH Isabelle - Remote sensing indicators to monitor forest degradation trough time in the Brazilian Amazon O59-04

Program detailed

Thursday 23 June 2016

S52 Part 2 | Free session: Tropical ecology
Sully 3 (Level 1)

14:30 ESQUIVEL MUELBERT Adriane - Large-scale Neotropical genera distributions predict drought - induced mortality of trees O52-11

14:45 VAN DER HEIJDEN Geertje - Lianas reduce carbon accumulation and storage: results from a liana removal experiment O52-12

15:00 HICK Aurélie - Impact of fire on resilience of tropical dry forests: miombo in Lubumbashi (Democratic Republic of Congo) O52-13

15:00 BOHR Yvonne - Altered patterns of natural hybridization induced by anthropogenic land use? Insights from a tarsier hybrid zone in Central Sulawesi O52-14

S63 | Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity
Antigone 1 (Level 2)

DEICHMANN Jessica, PALMINTERI Sue

14:30 PALMINTERI Suzanne - Wildtech.mongabay.com: an online hub for conservation technology O63-01

14:45 AIDE T. Mitchell - Why we need acoustic monitoring stations in every research station, ecolodge, and protected area across the tropics O63-02

15:00 RODRIGUEZ-PRIETO Ana - Addressing the biodiversity knowledge gap in tropical countries using Gene, a mobile expedition lab O63-03

15:15 DAVENPORT Lisa - Elucidating avian flyways in South America with satellite telemetry: state of knowledge and future directions O63-04

S66 | Evaluating the impacts of redd+ interventions on forests and people
Antigone 3 (Level 2)

DUCHELLE Amy, DE SASSI Claudio, SUNDERLIN William

14:30 WUNDER Sven - REDD projects in theory and practice O66-01

14:45 BOS Astrid B. - Assessing the effectiveness of subnational REDD+ initiatives by tree cover change analysis O66-02

15:00 ATMADJA Stibniati - Are households' forest clearing affected by REDD+? O66-03

15:15 RESOSUDARMO Ida Aju - The effectiveness of REDD+ initiatives in changing local people's emission-generating activities: household perspectives from Africa, Asia, and Latin America O66-04

S68 | Is habitat fragmentation driving tropical forests towards functional homogenization?
Rondelet (Level 2)

ZAMBRANO Jenny, BECKMAN Noelle, FORTUNEL Claire, GARZON Carol,

14:30 BENCHIMOL Maíra - Erosion in functional and phylogenetic diversity of insular tropical tree assemblages O68-07

14:45 MUNGUÍA-ROSAS Miguel - Patch isolation and shape predict plant functional diversity in a naturally fragmented Forest O68-08

15:00 RAY Rajasri - Functional importance of sacred forest patches in altered landscape O68-09

15:15 DANTAS DE PAULA Mateus - Simulating tree community dynamics under dispersal failure – Consequences of defaunation to ecosystem processes in fragmented forests O68-10

Thursday 23 June 2016

S72 | **Free session: Functional traits in tropical ecosystems**
Barthez (Level 2)

14:30	DEL PILAR AGUIRRE Martin Adriana - Ecological vulnerability of floristic diversity of tropical dry forest in the high Magdalena River Valley, Colombia, South America	O72-01
14:45	ARMSTRONG Ellie - Adaptation and population dynamics of a tropical spider, Ariamnes (Theridiidae)	O72-02
15:00	DURÁN-RANGEL Cristabel - Functional composition of montane tropical forests on contrasting geological formations (Guayana Shield and Andes)	O72-03
15:15	COELHO DE SOUZA Fernanda - Phylogenetic control of Amazonian tree traits	O72-04

15:30 - 16:00 Break & Poster Sessions (Level 1 & 2)

16:00 SYMPOSIA, ORAL SESSIONS & FREE SESSIONS

S54 | **Applying the nexus approach to understand tradeoffs and synergies between c harcoal, food and water production in tropical forests**
Pasteur (Level 0 & 1)
MWAMPAMBA Tuyeni, GHILARDI Adrian

16:00	LIYAMA Miyuki - Social-ecological systems contexts underlying the sustainability of charcoal value chains along the energy-water-food nexus in African landscapes	O54-05
16:15	GÓMEZ-TAGLE Alberto - Soil hydrological and physical properties in charcoal production landscapes	O54-06
16:30	MAASS Manuel - A long-term socioecosystem research approach to understand water dynamics in a tropical dry deciduous forest of México´s Western Coast	O54-07
16:45	GIAMPIETRO Mario - Integrated assessment of the nexus between charcoal, food, and water using MuSIASEM	O54-08

S56 | **Towards refined carbon budgets of managed forests**
Einstein (Level 0)
RUTISHAUSER Ervan, SIST Plinio, HÉRAULT Bruno

16:00	DE AVILA Angela Luciana - Effects of disturbance intensity and tree diversity on the biomass recovery of a managed tropical forest	O56-05
16:15	KUNERT Norbert - Species richness and ecosystem stability control carbon use efficiency of tropical forests	O56-06
16:30	BERENGUER Erika - Seeing the woods through the saplings: using wood density to assess post-disturbance recovery of human-modified tropical forests	O56-07
16:45	LEHNEBACH Romain - Xtrawood: refining estimation of tree above ground biomass using wood specific gravity variations and tree structure	O56-08

Thursday 23 June 2016

S59 | Mapping and monitoring tropical forest degradation with remote sensing

Sully 1 (Level 1)

GOND Valery, BLANC Lilian

16:00 KLEINSCHROTH Fritz - Roadless space and logging in intact forest landscapes of the Congo Basin O59-05

16:15 DEZECACHE Camille - Gold-rush in a forested El Dorado: long-term assessment of deforestation and policy issues O59-06

16:30 ROSOMAN Grant - Putting No Deforestation into Practice - using the High Carbon Stock Approach identify and conserve degraded tropical forests O59-07

16:45 RUTEBUKA Evariste - Application of remote sensing and GIS for multi-temporal assessment of forest coverage change detection and carbon sequestration: Case of Nyungwe national park, Rwanda O59-08

S52 Part 2 | Free session: Tropical ecology

Sully 3 (Level 1)

16:00 FAY Wilson Robyn - Large lizards adapting to urbanization O52-15

16:15 CARRASCO L. Roman - Global oil palm expansion modeling and implications for environmental certification schemes O52-16

16:30 RÜGER Nadja - Beyond the growth-survival trade-off: Demographic dimensions of tropical trees O52-17

16:45 DRAPER Frederick - Floristic dynamics in space and time in West Amazonian peatlands O52-18

S63 | Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity

Antigone 1 (Level 2)

DEICHMANN Jessica, PALMINTERI Sue

16:00 RASMUSSEN Henrik - Detect-deter-document: A new Human - Wildlife Conflict Reduction and Insurance System O63-05

16:15 ZAHAWI Rakan - Using lightweight unmanned aerial vehicles to monitor tropical forest recovery O63-06

16:30 BONNET Pierre - An Image-based Plant Identification Platform for Thousands of Species O63-07

16:45 AMÂNCIO ALVES EIGENHEER Milene - The history and a picture of movement ecology in Brazil O63-08

S66 | Evaluating the impacts of redd+ interventions on forests and people

Antigone 3 (Level 2)

DUCHELLE Amy, DE SASSI Claudio, SUNDERLIN William

16:00 SILLS Erin - Who will bear the cost of REDD+? Evidence from the incidence of implementation and opportunity costs in subnational REDD+ initiatives O66-05

16:15 DE SASSI Claudio - A pan-tropical assessment of REDD+ socioeconomic impacts on smallholders O66-06

Thursday 23 June 2016

S69 | **Free session: Habitat fragmentation and biodiversity**
Rondelet (Level 2)

16:00	ALMEIDA-GOMES Mauricio - Habitat amount predicts the functional diversity of amphibians in an Atlantic Forest fragmented landscape	O69-01
16:15	BOURG Amandine - Resource selection by dung beetles in Neotropical forest fragments and cattle pastures	O69-02
16:30	BRODIE Jedediah - Wildlife corridors for persistence of Borneo mammal metacommunities	O69-03
16:45	PALMEIRIM Ana Filipa - Lizard responses to habitat insularization induced by a mega hydroelectric dam in the lowland Amazon	O69-04

S72 | **Free session: Functional traits in tropical ecosystems**
Barthez (Level 2)

16:00	EWEDJE EBEN-EZER B.K. - Reproductive biology and gene dispersal of Pentadesma butyracea Sabine (Clusiaceae) in Benin	O72-05
16:15	FORTUNEL Claire - Functional trait differences influence neighborhood interactions in a hyperdiverse Amazonian forest	O72-06
16:30	POSADA Juan - The economy of non-structural carbohydrates and its relationship with plant functional traits in tropical and temperate tree species	O72-07
16:45	VACHER Jean-Pierre - Rapid shift of reproductive modes as a driver of diversification in the neotropics: the case of poison frogs	O72-08

17:00 **INTERLUDE**

17:30 **CLOSING CEREMONY, THE MONTPELLIER DECLARATION** *Pasteur (Level 0 & 1)*

19:00 **ATBC BANQUET**

MONDAY 20 JUNE 2016

	08:00	09:00	09:30	10:30	11:00	12:00	13:30	14:30	15:30	16:00	17:30	18:30
Pasteur (level 0 & 1)	Registration	Opening Welcome	**Plenary Session 1** Kaoru KITAJIMA Women in tropical biology and conservation	Break	**S1** Defaunation: a local process with global implications	Lunch	**Plenary Session 2** Robert NASI Tropical wildlife: a forgotten and threatened forest resource	**S1** Defaunation: a local process with global implications	Break	**S1** Defaunation: a local process with global implications	Poster Sessions	ATBC Town Hall Meeting
Einstein (level 0)					**S2** Success of tropical legumes and traits that contribute to their dominance			**S2** Success of tropical legumes and traits that contribute to their dominance		**S3** Model systems for studying the ecology and evolution of herbivore defence		
Sully 1 (level 1)					**S4** Termites, earthworms and tropical soils: thier diversity and conservation	ATBC Africa Chapter Tuyeni Mwampamba & Orou Gaoue		**S4** Termites, earthworms and tropical soils: thier diversity and conservation		**S5** Changes in floristic assem-blages through time: a view on short- and long-term (last decades to million years) dynamics		
Sully 3 (level 1)								**S6** Free session: Experimental methods in tropical ecology		**S6** Free session: Experimental methods in tropical ecology		
Antigone 1 (level 2)					**S7** The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest	Mentoring program Alice Hughes		**S8** Free session: Land use, landscape ecology, and conservation		**S8** Free session: Land use, landscape ecology, and conservation		
Antigone 3 (level 2)					**S9** Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)	Conservation Meeting Norbert Kunert & Pia Parolin		**S9** Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)		**S10** Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests		
Rondelet (level 2)					**S11 Part. 1** Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology	Moving forward in Academia Jennifer Powers		**S11 Part. 1** Tropical tree physiology. Part 1.Adaptations and responses to changes in soil water availa-bility tropical tree physiology		**S12** Free session: Plant physiology, and ecology		
Barthez (level 2)					**S13** Biodiversity conservation in a conflicting context - The case of the Congo basin	Writing and publication Tomas Carlo		**S13** Biodiversity conservation in a conflicting context - The case of the Congo basin		**S14** Mapping diversity: from gene to system		

TUESDAY 21 JUNE 2016

	08:00	08:30	09:30	10:00	12:00	13:30	14:30	15:30	16:00	17:30	18:30
Pasteur (level 0 & 1)	Registration	**Plenary Session 3** Karen KAINER Collaboration challenges and possibilities between local communities and scientists for shared learning and long-term conservation	Break	**S15** Ecosystem ecology of african forests	Lunch	**Plenary Session 4** Joachim CLAUDET Challenges in using human-nature interactions to better inform policy and assess management outcomes	**S15** Ecosystem ecology of african forests	Break	**S16** Understanding ecosystem services in the panama canal watershed: implications for sustainable land management	Poster Sessions	Gender Committee Workshop
Einstein (level 0)				**S17** Palm ecology in a changing world			**S18** Tropical plant-animal interactions in the anthropocene		**S18** Tropical plant-animal interactions in the anthropocene		
Sully 1 (level 1)				**S19** Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments	ATBC Africa Chapter (continued)		**S19** Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments		**S20** Free session: Plant-microbial interactions		
Sully 3 (level 1)				**S21** The ecological importance of tank-forming plants in tropical rainforests			**S22** Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture		**S23** Chemical ecology: new insight in comprehending biotic interactions in the tropics		
Antigone 1 (level 2)				**S24** The future of tropical montane forests: biodiversity, climate change, land use, and conservation	Mentoring program Continued		**S24** The future of tropical montane forests: biodiversity, climate change, land use, and conservation		**S25** Harvest as herbivory: New developments in theoretical and empirical models		
Antigone 3 (level 2)				**S26** Ecological impacts of forest disturbance in the brazilian amazon	Conservation Meeting Continued		**S27** Long-term trends of tropical plant phenology: consequences for plants and consumers		**S27** Long-term trends of tropical plant phenology: consequences for plants and consumers		
Rondelet (level 2)				**S11 Part. 2** Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources	Tropical Drought: Processes and Tipping Points Discussion Amy Zanne, Lucas Cernusak, Alex Cheesman		**S28** Primates on the move: from local to landscape scale		**S28** Primates on the move: from local to landscape scale		
Barthez (level 2)				**S29** Impacts of drought on tropical forests: processes and tipping points	Resolutions in conservation: Pia Parolin, Sophie Calme, & Alice Hughes		**S29** Impacts of drought on tropical forests: processes and tipping points		**S30** Manipulation experiments for understanding tropical ecosystem responses to habitat modification		

WEDNESDAY 22 JUNE 2016

	08:00	08:30	09:30	10:00	12:00	13:30	14:30	15:30	16:00	17:30	18:30
Pasteur (level 0 & 1)	Registration	**S31** Next generation forest science, managing and restoring tropical forest genetic resources	Break	**S31** Next generation forest science, managing and restoring tropical forest genetic resources	Lunch	**Plenary Session 5** Marielos PENA-CLAROS Conserving tropical forests: the potential role of sustainable forest management	**S32** Europe's role in driving the future of tropical forested landscapes	Break	**S32** Europe's role in driving the future of tropical forested landscapes	Poster Sessions	Photo Conference
Einstein (level 0)		**S33** Free session: The conservation of plant-animal interactions in a changing world		**S34** Free session: Tropical forest ecology, conservation and management			**S34** Free session: Tropical forest ecology, conservation and management		**S35** Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future		
Sully 1 (level 1)		**S36** Free session: Biodiversity and palm oil plantations		**S37** Free session: Tropical ecology and society in African ecosystems	ATBC Africa Chapter (continued)		**S38** A brave new world: integrating wellbeing and justice in conservation		**S38** A brave new world: integrating wellbeing and justice in conservation		
Sully 3 (level 1)		**S39** Defaunation: a local process with global implications		**S40** Tropical tree structure and function: directions and gaps four decades after Halle			**S41** Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned		**S42** Developing research capacity on biodiversity and conservation: a caribbean challenge		
Antigone 1 (level 2)		**S43** Human-nature interactions in tropical landscapes		**S43** Human-nature interactions in tropical landscapes	Mentoring program Continued		**S44** Free session: Secondary forest succession and restoration		**S44** Free session: Secondary forest succession and restoration		
Antigone 3 (level 2)				**S45** Biodiversity patterns and processes along altitudinal gradients in tropical forests	Conservation Meeting Continued		**S45** Biodiversity patterns and processes along altitudinal gradients in tropical forests		**S46** Free session: Climate change in tropical ecosystems		
Rondelet (level 2)				**S47** Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration	Discussion panel Continued		**S48** Free session: Ecology and conservation of tropical soils		**S49** Fire and biodiversity in the tropics: contrasting savannas and forests		
Barthez (level 2)		**S50** Free session: Methods and metrics to evaluate and measure forest degradation		**S51** Pattern and process in tropical mammal communities: a camera trapping perspective	Writing blog-type articles: Jaboury Ghazoul		**S52 Part. 1** Free session: Tropical ecology		**S52 Part. 1** Free session: Tropical ecology		

THURSDAY 23 JUNE 2016

	08:00	10:00	10:30	12:00	13:30	14:30	15:30	16:00	17:00	17:30	19:00
Pasteur (level 0 & 1)	**S53** Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation	Break & Poster Session	**S53** Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation	Lunch	**Plenary Session 6** Tuyeni MWAMPAMBA The future role and key challenges of biodiversity conservation and use in Africa	**S54** Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests	Break & Poster Session	**S54** Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests	Interlude	Closing Ceremony	ATBC Banquet
Einstein (level 0)	**S55** Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome		**S55** Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome - Game			**S56** Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome		**S56** Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome			
Sully 1 (level 1)	**S57** Free session: Intraspecific variation in tropical trees – implication for tropical forest responses to global change		**S58** Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing			**S59** Mapping and monitoring tropical forest degradation with remote sensing		**S59** Mapping and monitoring tropical forest degradation with remote sensing			
Sully 3 (level 1)	**S60** Management impacts on biodiversity and carbon/nutrient balances in the tropics		**S61** Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics			**S52 Part. 2** Free session: Tropical ecology		**S52 Part. 2** Free session: Tropical ecology			
Antigone 1 (level 2)	**S62** Disrupted species interactions and cascade effects in human-modified landscapes		**S62** Disrupted species interactions and cascade effects in human-modified landscapes	Mentoring program Continued		**S63** Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity		**S63** Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity			
Antigone 3 (level 2)	**S64** Towards an unified vision of the central african forests		**S65** Subsistence hunting in the tropics: A coupled human natural system perspective	Getting your work published in the Sciences Steve Turton		**S66** Evaluating the impacts of redd+ interventions on forests and people		**S66** Evaluating the impacts of redd+ interventions on forests and people			
Rondelet (level 2)	**S67** Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation		**S68** Is habitat fragmentation driving tropical forests towards functional homogenization?	Discussion panel Continued		**S68** Is habitat fragmentation driving tropical forests towards functional homogenization?		**S69** Free session: Habitat fragmentation and biodiversity			
Barthez (level 2)	**S70** Systems view of agro-ecological landscapes		**S71** Functional traits in tropical agroecology	Meet the editors Emilio Bruna		**S72** Free session: Functional traits in tropical ecosystems		**S72** Free session: Functional traits in tropical ecosystems			

Scientific Program

■ LIST OF PLENARY SESSIONS

Plenary Session 1 Monday 20 June / 9:30-10:30 - Pasteur
Pr. Kitajima KAORU, Kyoto University
Women in tropical biology and conservation
Introduced by **Pr. Robin CHAZDO**N, ATBC ED, Univ. Connecticut

Plenary Session 2 Monday 20 June / 13:30-14:30 - Pasteur
Dr. Robert NASI, Deputy Director General-Research, CIFOR
Tropical wildlife: a forgotten and threatened forest resource
Introduced by **Dr. Plinio SIST,** CIRAD

Plenary Session 3 Tuesday 21 June / 8:30-9:30 - Pasteur
Pr. Karen A. KAINER, Professor University of Florida
Collaboration challenges and possibilities between local communities and scientists for shared learning and long-term conservation
Introduced by **Pr. Pierre-Michel FORGET**, MNHN

Plenary Session 4 Tuesday 21 June / 13:30-14:30 - Pasteur
Dr. Joachim CLAUDET, Researcher, CNRS
Challenges in using human-nature interactions to better inform policy and assess management outcomes
Introduced by **Dr. Stéphanie CARRIÈRE**, IRD-GRED

Plenary Session 5 Wednesday 22 June / 13:30-14:30 - Pasteur
Dr. M (Marielos) PEÑA-CLAROS MSc, Associate Professor, Wageningen University
Conserving tropical forests: the potential role of sustainable forest management
Introduced by **Dr. Miguel MARTINEZ-RAMOS**, Chair ATBC17, UNAM

PS6 - Plenary Session 6 Thursday 23 June / 13:30-14:30 - Pasteur
Dr. Tuyeni MWAMPAMBA, Researcher, UNAM-CIEco
The future role and key challenges of biodiversity conservation and use in Africa
Introduced by **Dr. Pia PAROLIN**, INRA and Univ. Hamburg

■ LIST OF LUNCH SESSIONS

Monday 20 June - 12:00-13:15
- ATBC Africa Chapter: Tuyeni Mwampamba, Orou Gaoue - Sully 1
- Mentoring program: Alice Hughes - Antigone 1
- Conservation Meeting: Norbert Kunert & Pia Parolin - Antigone 3
- Writing and publication: Tomas Carlo - Rondelet
- Moving forward in Academia: Jennifer Powers - Barthez

Tuesday 21 June - 12:00-13:15
- ATBC Africa Chapter: Continued - Sully 1
- Mentoring program: Continued - Antigone 1
- Conservation Meeting: Continued - Antigone 3
- Tropical Drought: Processes and Tipping Points Discussion Amy Zanne, Lucas Cernusak & Alex Cheesman - Rondelet
- Resolutions in conservation: Pia Parolin, Sophie Calme, and Alice Hughes - Barthez

Wednesday 22 June - 12:00-13:15
- ATBC Africa Chapter: Continued - Sully 1
- Mentoring program: Continued - Antigone 1
- Conservation Meeting. Continued - Antigone 3
- Discussion panel: Continued - Rondelet
- Writing blog-type articles: Jaboury Ghazoul - Barthez

Scientific Program

Thursday 23 June - 12:00-13:15
- Mentoring program: Continued - Antigone 1
- Getting your work published in the Sciences: Steve Turton - Antigone 3
- Discussion panel: Continued - Rondelet
- Meet the editors: Emilio Bruna - Barthez

Mentoring program / Alice Hughes Chair Training Activities / Monday-to-Thursday. Antigone1.

http://www.atbc2016.org/EN/events.php?IDManif=837&IDModule=71&IDRub=2118

Mentoring can serve many functions, but in general it is to build the Mentees abilities as a researcher, to help them realize and build upon their strengths and weaknesses, and to look forward and plan their research and professional trajectories.

At the ATBC with the help of our diverse membership we aim to help cultivate the very best in the next generation of researchers, and to help them reach their potential.

All mentors will fill in an online profile prior to the conference, then one week before the conference Mentor registration will close, and their profiles made available for students to select a mentor for the conference; which each mentee will do online. Choosing a mentor will reflect the needs of the individual mentee, whether that be discussing the intricacies of how leking fruit bats attract a mate, planning your future career or discussing areas you feel you could improve and how.

Near the beginning of the conference we will have our opening event, where mentors and mentees will get to know each other over refreshments. A detailed workbook will be sent around in advance to facilitate those interactions.

Mentors and mentees will be encouraged to plan their conference together and to meet up a number of times during the conference, so the mentee can get the very best conference experience, and gain new skills and perspectives, and plan their future growth.

• ATBC Conservation Committee Open Forum / **Norbert KUNERT & Pia PAROLIN** Conservation Committee / Monday-to-Wednesday. Antigone2.
Please join us for the open forum of ATBC Conservation Committee in order to identify key conservation issues that are relevant in Europe, as well as tropical biomes at large.

• Moving forward in Academia / **Jennifer POWERS** / Monday 20 June -Barthez
So you just defended your thesis, or will soon... What comes next? We will discuss options, strategies, and planning for your life post-PhD.

• Writing and publication / **Tomas CARLO**/ Monday 20 June - Rondelet
Need to get published? Learn effective strategies for writing a manuscript and getting published

Please join us for the open forum of ATBC Conservation Committee in order to identify key conservation issues that are relevant in Europe, as well as tropical biomes at large.

• Resolutions in conservation / **Pia PAROLIN, Sophie CALMÉ & Alice HUGHES** / Tuesday 21 June - Barthez
How do we effectively turn conservation priorities into conservation practice in the real world?

• Writing blog-type articles / **Jaboury GHAZOUL** / Wednesday 22 June - Barthez
What is the point of a science blog? Is it really worth the effort? Who reads them anyway? And who are they for? And once you have decided to write one, how do you do it?

• Meet the editors / **Emilio BRUNA** / Thursday 23 June - Barthez
Meet the Editors of Biotropica: where is the ATBC's journal going and what do I need to do to so my papers are in it?

• Getting published in the Sciences / **Steve TURTON** / Thursday 23 June - Antigone 2
Skills and tips to get your research published

This session is aimed at PhD students and postdocs. It will cover preparing a paper for submission, avoiding and dealing with rejection, selecting the right journal to publish in, rules for writing good scientific articles, multidisciplinary and transdisciplinary research articles, impact factors (citation indices), co-authorship protocols, digital publications and Researcher ID.

• Tropical Drought: Processes and Tipping Points Discussion /
Amy ZANNE, Lucas CERNUSAK & Alex CHEESMAN / Tuesday-to-Thursday - Rondelet

We will hold a lunchtime panel and audience discussion on tropical drought tied to the Symposium 29 "Impacts of drought on tropical forests: processes and tipping points" led by Amy Zanne (The George Washington University), Lucas Cernusak (James Cook University) and Alex Cheesman (James Cook University) on Tuesday 21st. We will have a range of experts on the topic, studying drought in different places around the world, at different temporal and spatial scales and with different experimental approaches. We look forward to active audience participation in bringing their experiences and opinions on this topic to a public forum. Possible questions we hope to cover include:

1. Is 'drought' different in different regions of the world? Why is this if so, and what are the different consequences for forests in these regions under future climate scenarios?
2. How well are we measuring and predicting drought responses of tropical forests using different approaches: observational, experimental, modeling? Are these approaches currently being integrated well? If so, how and if not, how can we improve?
3. What are our best predictors of likely drought impacts on forests (e.g. physical climate monitoring, enumerating plant functional traits, or monitoring plant ecophysiology and whole forest responses)?
4. How does the above knowledge help us to mitigate forest decline and dieback due to drought under climate change scenarios?
5. Or other questions as suggested by our panel and audience
   We hope that these discussions may lead to new collaborations, such as projects, grant proposals, or manuscript syntheses. For updates you can follow us on Twitter at @atbc2016 #atbc16-drought and Facebook at ATBC2016. If you have any questions, please contact Amy Zanne (aezanne@gmail.com), Lucas Cernusak (lcernusak@gmail.com), and/or Alex Cheesman (alex.cheesman@jcu.edu.au).

• ATBC Africa Chapter / Tuyeni Mwampamba & Orou Gaoue / Monday-To-Wednesday - Sully 1
Those interested in joining the structure and organization of the ATBC Africa Chapter are invited to join the discussion meeting.

■ LIST OF SYMPOSIA & FREE SESSIONS

S1 Defaunation: a local process with global implications
Monday 20 June / 11:00-17:30 - Pasteur
TERBORGH John, PAINE C. E. Timothy, PRINGLE Elizabeth, HAZELWOOD Kirsten

S2 Success of tropical legumes and traits that contribute to their dominance
Monday 20 June / 11:00-15:30 - Einstein
GEI Maria, DEXTER Kyle, POWERS Jennifer

S3 Model systems for studying the ecology and evolution of herbivore defence
Monday 20 June / 16:00-17:30 - Einstein
DEXTER Kyle

S4 Termites, earthworms and tropical soils : their diversity and conservation
Monday 20 June / 11:00-15:30 - Sully1
DECAENS Thibaud, FREYCON Vincent, MCKEY Doyle, JIMENEZ Juan Jose

S5 Changes in floristic assemblages through time : a view on short- and long-term (last decades to million years) dynamics
Monday 20 June / 16:00-17:30 - Sully1
LEDRU Marie-Pierre, FAVIER Charly

S6 Free session: Experimental methods in tropical ecology
Monday 20 June / 14:30-17:30 - Sully 3

S7 The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest
Monday 20 June / 11:00-12:00 - Antigone1
LOHMANN Lucia, CARNAVAL Ana Carolina

S8 Free session: Land use, landscape ecology, and conservation
Monday 20 June – 14:30-17:30 - Antigone1

S9 Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)
Monday 20 June / 11:00-15:30 - Antigone3
FONTY Emile, HEURET Patrick, DE RIDDER, CARAGLIO Yves, OUEDRAOGO Dakis-Yaoba

S10 Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests
Monday 20 June / 16:00-17:30 - Antigone3
FAYOLLE Adeline, BEECKMAN Hans, STOFFELEN Piet, VAN ACKER Joris, DE RIDDER Maaike

S11 Part1 Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology
Monday 20 June / 11:00-15:30 - Rondelet
GOLDSTEIN Guillermo, SANTIAGO Louis S.

S11 Part2 Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resourcesnutrient and light resources
Tuesday 21 June / 10:00-12:00 - Rondelet
GOLDSTEIN Guillermo, SANTIAGO Louis S.

S12 Free session: Plant physiology, and ecology
Monday 20 June / 16:00-17:30 - Rondelet

S13 - Biodiversity conservation in a conflicting context - The case of the Congo basin
Monday 20 June / 11:00-15:30 - Barthez
DOUMENGE Charles, PALLA Florence, REGNAUT Sébastien

S14 Mapping diversity: from gene to system
Monday 20 June / 16:00-17:30 - Barthez
HUGHES Alice

S15 Ecosystem ecology of african forests
Tuesday 21 June – 10.00-15.30 - Pasteur
MOORE Sam, ADU-BREDU Stephen, MITCHARD Edward, CARDOSA Anabelle

S16 Understanding ecosystem services in the panama canal watershed: implications for sustainable land management
Tuesday 21 June / 16:00-17:30 - Pasteur
HALL Jefferson, VAN BREUGEL Michiel

S17 Palm ecology in a changing world
Tuesday 21 June / 10:00-12:00 - Einstein
DRACXLER Caroline Marques, PORTELA RITA DE CÁSSIA Quitete,
PIRES DOS SANTOS Alexandra

Scientific Program

S18 Tropical plant-animal interactions in the anthropocene
Tuesday 21 June / 14:30-17:30 - Einstein
KUPREWICZ Erin, GARCIA-ROBLEDO Carlos

S19 Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments
Tuesday 21 June / 10:00-15:30 - Sully1
MCGUIRE Krista, SELOSSE Marc-André, BREARLEY Francis

S20 Free session: Plant-microbial interactions
Tuesday 21 June / 16:.00-17:30 - Sully1
ROY Mélanie

S21 The ecological importance of tank-forming plants in tropical rainforests
Tuesday 21 June – 10:00-12:00 - Sully 3
CEREGHINO Regis, GAUME Laurence

S22 Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture
Tuesday 21 June / 14:30-15:30 - Sully 3
BLATRIX Rumsais, MCKEY Doyle, RENARD Delphine

S23 Chemical ecology: new insight in comprehending biotic interactions in the tropics
Tuesday 21 June / 16:00-17:30 - Sully3
PROFFIT Magali, DI GIUSTO Bruno, HOSSAERT-MCKEY Martine

S24 The future of tropical montane forests: biodiversity, climate change, land use, and conservation
Tuesday 21 June / 10:00-15:30 - Antigone1
GEML József, LEONARD Jennifer, TER STEEGE Hans

S25 Harvest as herbivory: New developments in theoretical and empirical models
Tuesday 21 June / 16:00-17:30 - Antigone1
GAOUE Orou, ZUIDEMA Pieter

S26 Ecological impacts of forest disturbance in the brazilian amazon
Tuesday 21 June / 10:00-12:00 - Antigone3
FERREIRA Joice, SIST Plinio

S27 Long-term trends of tropical plant phenology: consequences for plants and consumers
Tuesday 21 June / 14:30-17:30 - Antigone3
MENDOZA Irene, ABERNETHY Katharine, BUSH Emma, BUNNEFELD Nils, MORELLATO Patricia, FORGET Pierre-Michel

S28 Primates on the move: from local to landscape scale
Tuesday 21 June / 14:30-17:30 - Rondelet
HUYNEN Marie, CULOT Laurence

S29 Impacts of drought on tropical forests: processes and tipping points
Tuesday 21 June / 10:00-15:30 - Barthez
ZANNE Amy, CERNUSAK Lucas, CHEESMAN Alex

S30 Manipulation experiments for understanding tropical ecosystem responses to habitat modification
Tuesday 21 June / 16:00-17:30 - Barthez
ASHTON Louise, GRIFFITH Hannah, PARR Kate

S31 Next generation forest science, managing and restoring tropical forest genetic resources
Wednesday 22 June / 08:30-12:00 - Pasteur
TITO DE MORAIS Claire, KETTLE Christopher J., SCOTTI Ivan

S32 Europe's role in driving the future of tropical forested landscapes
Wednesday 22 June / 14:30-17:30 - Pasteur
GHAZOUL Jaboury

S33 Free session: The conservation of plant-animal interactions in a changing world
Wednesday 22 June / 08:30-09:30 - Einstein
Plinio SIST

S34 Free session: Tropical forest ecology, conservation and management
Wednesday 22 June / 10:00-15:30 - Einstein
Plinio SIST

S35 Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future
Wednesday 22 June / 16:00-17:30 - Einstein
MUNOZ François, DAVIDAR Priya

S36 Free session: Biodiversity and palm oil plantations
Wednesday 22 June / 08:30-09:30 - Sully1

S37 Free session: Tropical ecology and society in African ecosystems
Wednesday 22 June / 10:00-12:00 - Sully1

S38 A brave new world: integrating wellbeing and justice in conservation
Wednesday 22 June / 14:30-17:30 - Sully1
GROSS-CAMP Nicole, BIEDENWEG Kelly, WOODHOUSE Emily, BURGESS Neil

S39 Capacity building for conservation and sustainable use: challenges and solutions to measuring impact
Wednesday 22 June / 08:30-09:30 - Sully3
TREVELYAN Rosie, KAPLIN Beth

S40 Tropical tree structure and function: directions and gaps four decades after Halle
Wednesday 22 June/ 10:00-12:00 - Sully3
SHENKIN Alexander, HALLÉ Francis, MALHI Yadvinder

S41 Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned
Wednesday 22 June / 14:00-15:30 - Sully 3
LOHMANN Lúcia, MWAMPAMBA Tuyeni, BALVANERA Patricia

S42 Developing research capacity on biodiversity and conservation: a caribbean challenge
Wednesday 22 June / 16:00-17:30 - Sully 3
CEZILLY Frank

S43 Free session: Human-nature interactions in tropical landscapes
Wednesday 22 June / 08:30-12:00 - Antigone 1

S44 Free session: Secondary forest succession and restoration
Wednesday 22 June / 14:30-17:30 - Antigone 1
CHAZDON Robin

S45 Biodiversity patterns and processes along altitudinal gradients in tropical forests
Wednesday 22 June / 10:00-15:30 - Antigone 3
GONMADJE Christelle, FLORES Olivier, DOUMENGE Charles

Scientific Program

S46 Free session: Climate change in tropical ecosystems
Wednesday 22 June / 16:00-17:30 - Antigone 3

S47 Tropical grassy biomes: Part 1. Grassland ecology, conservation and restoration
Wednesday 22 June / 10:00-12:00 - Rondelet
BUISSON Elise

S48 Free session: Ecology and conservation of tropical soils
Wednesday 22 June / 14:30-15:30 - Rondelet

S49 Fire and biodiversity in the tropics: contrasting savannas and forests
Wednesday 22 June / 16:00-17:30 - Rondelet
CAMPOS Ricardo, VASCONCELOS Heraldo

S50 Free session: Methods and metrics to evaluate and measure forest degradation
Wednesday 22 June / 08:30 - 09:30 - Barthez

S51 Pattern and process in tropical mammal communities: a camera trapping perspective
Wednesday 22 June / 10:00-12:00 - Barthez
JANSEN Patrick, ROWCLIFFE Marcus, CARBONE Chris

S52 Part 1 Free session: Tropical ecology
Wednesday 22 June / 14:30-17:30 - Barthez

S52 Part 2 Free session: Tropical ecology
Thursday 23 June / 14:30-17:00 - Sully 3

S53 Tipping points in madagascar's anthroposphere: integrating human needs with ecosystem conservation
Thursday 23 June / 08:00-12:00 - Pasteur
RAZAFINDRATSIMA Onja, GANZHORN Joerg, CARRIERE Stephanie

S54 Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests
Thursday 23 June / 14:30-17:00 - Pasteur
MWAMPAMBA Tuyeni, GHILARDI Adrian

S55 Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome
Thursday 23 June / 08:00-10:00 - Einstein
CORNELIS Daniel, LE BEL Sébastien, VERMEULEN Cédric

S56 Towards refined carbon budgets of managed forests
Thursday 23 June / 14:30-17:00 - Einstein
RUTISHAUSER Ervan, SIST Plinio, HÉRAULT Bruno

S57 Intraspecific variation in tropical trees - implications for tropical forest responses to global change
Thursday 23 June / 08:00-10:00 - Sully 1
COMITA Liza, ENGELBRECHT Bettina, Jones F. Andrew

S58 Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing
Thursday 23 June / 10:30-12:00 - Sully1
GOND Valery, HELMER Eileen

S59 Mapping and monitoring tropical forest degradation with remote sensing
Thursday 23 June / 14:30-17:00 - Sully1
GOND Valery, BLANC Lilian

Scientific Program

S60 Management impacts on biodiversity and carbon/nutrient balances in the tropics
Thursday 23 June / 08:00-10:00 - Sully3
PIETSCH Stephan, PENUELAS Josep, CIAIS Philippe, JANSSENS Ivan, OBERTSEINER Michael

S61 Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics
Thursday 23 June / 10:30-12:00 - Sully 3
CALMÉ Sophie, WHITE Rehema, LÉCUYER Lou

S62 Disrupted species interactions and cascade effects in human-modified landscapes
Thursday 23 June / 08:00-12:00 - Antigone1
TABARELLI Marcelo, LEAL Inara

S63 Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity
Thursday 23 June / 14:30-17:00 - Antigone1
DEICHMANN Jessica, PALMINTERI Sue

S64 Towards an unified vision of the central african forests
Thursday 23 June / 08:00-10:00 - Antigone3
GOURLET-FLEURY Sylvie, FAYOLLE Adeline, PELISSIER Raphaël

S65 Subsistence hunting in the tropics: A coupled human natural system perspective
Thursday 23 June / 10:00-12:00 - Antigone3
FRAGOSO Jose (Joe) Manuel.V, SILVIUS Kirsten Mariana

S66 Evaluating the impacts of REDD+ interventions on forests and people
Thursday 23 June / 14:30-17:00 - Antigone3
DUCHELLE Amy, DE SASSI Claudio, SUNDERLIN William

S67 Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation
Thursday 23 June / 08:00-10:00 - Rondelet
LEHMANN Caroline, PARR Catherine

S68 Is habitat fragmentation driving tropical forests towards functional homogenization?
Thursday 23 June / 10:30-15:30 - Rondelet
ZAMBRANO Jenny, BECKMAN Noelle, FORTUNEL Claire, GARZON Carol

S69 Free session: Habitat fragmentation and biodiversity
Thursday 23 June / 16:00-17:00 - Rondelet

S70 Systems view of agro-ecological landscapes
Thursday 23 June / 08:00-10:00 - Barthez
MOREL Alexandra, HIRONS Mark, NORRIS Ken

S71 Functional traits in tropical agroecology
Thursday 23 June / 10:30-12:00 - Barthez
MARNEY Isaac, ADAM Martin

S72 Free session: Functional traits in tropical ecosystems
Thursday 23 June / 14:30-17:00 - Barthez

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Monday 20 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

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Monday 20 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

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Scientific Program

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S46 Free session: Climate change in tropical ecosystems
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S47 Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration
Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

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Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

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Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

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S54 Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests
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S59 Mapping and monitoring tropical forest degradation with remote sensing
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S62 Disrupted species interactions and cascade effects in human-modified landscapes
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S69 Free session: Habitat fragmentation and biodiversity
Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

S71 Functional traits in tropical agroecology
Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

S72 Free session: Functional traits in tropical ecosystems
Wednesday 22 June / 17:30 - 18:30 - Poster Sessions Area (Level 1)

■ LIST OF WORKSHOPS

TRAINING WORKSHOPS

ATBC is organizing a number of training courses workshops for students and conservationists around our Montpellier meeting. This will include several popular courses that are our trademark, as well as some new offerings. The courses are aimed to develop capacity and skills in a range of areas needed by today's tropical biologists and conservation scientists. These workshops are open to all ATBC members and we encourage participants from developing countries where the instruction in not normally available in learning institutions. At this time we are please to announce the following:
• Advanced Statistics (13-18th June 2016)
• Fundamentals of GIS for ecology, and species distribution modeling workshop (24-28th June 2016)

ATBC Conservation Committee Open Forum / **Pia PAROLIN** / Chair Conservation Committee
Please join us for the open forum of ATBC Conservation Committee in order to identify key conservation issues that are relevant in Europe, as well as tropical biomes at large. Monday – Tuesday - 12:00-13:30. Einstein.

MENTORING PROGRAM

Alice HUGHES / Chair Training Activities
Mentoring can serve many functions, but in general it is to build the Mentees abilities as a researcher, to help them realize and build upon their strengths and weaknesses, and to look forward and plan their research and professional trajectories. At the ATBC with the help of our diverse membership we aim to help cultivate the very best in the next generation of researchers, and to help them reach their potential.
All mentors will fill in an online profile prior to the conference, then one week before the conference Mentor registration will close, and their profiles made available for students to select a mentor for the conference; which each mentee will do online. Choosing a mentor will reflect the needs of the individual mentee, whether that be discussing the intricacies of how leking fruit bats attract a mate, planning your future career or discussing areas you feel you could improve and how. Near the beginning of the conference we will have our opening event, where mentors and mentees will get to know each other over refreshments. A detailed workbook will be sent around in advance to facilitate those interactions.
Mentors and mentees will be encouraged to plan their conference together and to meet up a number of times during the conference, so the mentee can get the very best conference experience, and gain new skills and perspectives, and plan their future growth.

Gender Committee Workshop

Tuesday 21 June / 18:30-19:30 – Pasteur

BALTER MICHAEL
Adjunct Professor of Journalism, New York University

Over the past year or two, the scientific community has seen an explosion of alleged cases of sexual harassment and sexual misconduct in fields as diverse as astronomy, molecular biology, and paleoanthropology. In the past, most of these cases would almost certainly have not seen the light of day. But a growing awareness of the seriousness of the problem, especially in field research, is now emerging, helped by considerable news media attention to episodes involving major scientific figures. It might also be said that the number of women who are either senior in their careers or well established has now reached a critical mass, to the point that they are able to make their voices of protest heard. Although this phenomenon is particularly advanced in the United States, there are lessons for researchers in every country. The author will describe in detail his investigation of one case, the allegations against the curator of human origins at the American Museum of Natural History, and describe the important impact these revelations have had on the field of anthropology. He will also discuss in some detail the kinds of enhanced guidelines and procedures now being adopted by numerous scientific organizations to enforce a "no tolerance" policy for sexual misconduct and harassment.

Photo Conference

Wednesday 22 June / 18:30-19:30 – Pasteur

ZIEGLER CHRISTIAN
Wildlife-and conservation Photographer, Contributing photographer, NATIONAL GEOGRAPHIC MAGAZINE

Presentation: Jungle Spirits – celebrating tropical biodiversity

National Geographic photographer and tropical ecologist Christian Ziegler takes us on a fascinating journey through tropical rainforests around the world, sharing images from some of his projects. Starting out at a flowering Balsa tree in his chosen home Panama, where he spent months on a scaffold he erected in the rainforest to document the diverse wildlife. We then follow his adventures in the Congo basin while taking images of our closest relatives, the bonobos, for the first time in the wild. Further to the East, we get to see threatened chameleons on the island of Madagascar, exciting recent discoveries in the world of carnivorous plants, and the long process of photographing one of the biggest, and yet most elusive and highly endangered birds on the planet, the Southern Cassowary, in the forests of tropical Queensland. With his photography Christian wants to excite you about the wonders of the natural world and highlight the urgent need for effective conservation. This will be presented as a slide show. Christian recently suffered a stoke and he is relearning English, which is why there is no talk. I am very sorry - you will have to wait until next year for the full presentation!

Plenary Session 1
Monday 20 June / 09:30-10:30 – Pasteur

Women in tropical biology and conservation
KITAJIMA KAORU, Professor, Kyoto University

As the President of ATBC for 2016, I would like to pay tribute to women in tropical biology and conservation. It is a timely occasion to look back on the history as we recognize Dr. Savitri Gunatilleke as our new Honorary Fellow (HF) this year. In the group photo of 33 taken at the Neotropical Botany Congress in 1962 when ATBC was created, there was just one woman, Mildred E. Mathias (HF 1986). Women were rare in field biology in general until recent decades, but there were notable exceptions such as Evelyn L. Cheesman (HF 1969) and Betty Meggers (HF 1994) who challenged conventional ways of thinking in their fields. All together, six out of 90 ATBC honorary fellows between 1963 and 2016 have been women, including Louis Emmons (HF 2008) and Julie Denslow (HF2009, President 1988, Executive Director 1989-1998). Scientific contributions by these, as well as many other women, who paved the way for later generations of female scientists need to be honored, especially given the challenges of breaking social stereotypes. The number of female tropical biologists has steadily increased during the last five decades, and more than half of the organizers of this year's symposia (35 out of 66) are women who span widely in their age and experience. Many women provide important service to social and academic organizations including ATBC. Yet, statistics show that female scientists continue to compare poorly to male peers in promotion, salary, and social recognition. I firmly believe that individual differences outweigh difference of averages between men and women, but perhaps women tend to take roles of helping others rather than being self-promotional. We need a bit of paradigm shift in recognizing networking ability, rather than stars, in tropical biology and conservation.

Plenary Session 2
Monday 20 June / 13:30-14:30 – Pasteur

Tropical wildlife: a forgotten and threatened forest resource
ROBERT NASI, Deputy Director General-Research, CIFOR

SUMMARY: Protein from forest wildlife (including fish) is crucial to food security, nutrition and health across the tropics. The harvest of duikers, antelopes, pigs, primates, rodents, birds, reptiles and fish provides invaluable benefits to local people both in terms of income and of improved nutritious diets. It also creates, often linked with commercialization, some very important health issues with the spread of several life-threatening diseases (Ebola, SARS). Vulnerability of the resource to harvest varies, with some species sustaining populations in heavily hunted secondary habitats, while others require intact forests with minimal harvesting to maintain healthy populations. Global attention has been drawn to biodiversity loss through debates regarding bushmeat, the «empty forest» syndrome and their ecological importance. However, information on the harvest and the trade remains fragmentary, along with understanding of their ecological, socioeconomic and cultural dimensions. Here we assess the consequences, both for ecosystems and local livelihoods, of the loss of these important resources and propose alternative management options.
KEYWORDs: wildlife, biodiversity, livelihoods, health, nutrition tropical forest

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Plenary Session 3
Tuesday 21 June / 08:30-09:30 – Pasteur

Collaboration challenges and possibilities between local communities and scientists for shared learning and long-term conservation
KAREN KAINER, Professor University of Florida

Local communities make many key decisions regarding the fate of the ecosystems in which they reside and the biodiversity which they use. The global trend (stronger in some regions of the world than others) to devolve resource decision-making and conservation responsibilities to local levels is strong evidence of a general belief that local governance has merit. While rural communities are most proximate to the remarkable world of tropical biodiversity, a plethora of higher-level interests also play an enormous role in landscape fate. In light of these realities, I turn our attention to the possibilities and challenges that established and upcoming scientists and practitioners from both sides of the equator face when seeking more effective, efficient and meaningful tropical conservation partnerships. I argue that an inclusive, thoughtful agenda that centers on the local, and integrates and invests in a spectrum of actors and approaches, is a promising way forward for tropical conservation.

Plenary Session 4
Tuesday 21 June / 13:30-14:30 – Pasteur

Challenges in using human-nature interactions to better inform policy and assess management outcomes
JOACHIM CLAUDET, Researcher, CNRS

Local and global changes are transforming ecosystems worldwide. Understanding and predicting how these transformations affect local communities and developing effective mitigation or adaptation measures are now pressing issues. It is now clear that those solutions need to be framed within an interdisciplinary, social-ecological, biocultural context. Multiple disciplines can synergistically produce scientific knowledge that can be used by or for communities to improve livelihoods while ensuring ecological resilience, economic viability, and social equity. Conceptual frameworks have been developed in this respect but prior to be locally operational and lead to effective decision and management support tools, several challenges need to be overcome, including modelling the complexity of social-ecological systems, incorporating local cultural perceptions, understanding the landscapes ensuring planning legitimacy and measuring social, environmental and financial costs of transformations. Once these challenges are addressed scenarios can be built and alternative management outcomes can be tested. Conceptual frameworks and challenges are reviewed and operational examples are given from French Polynesia.

Plenary Session 5
Wednesday 22 June / 13:30-14:30 – Pasteur

Conserving tropical forests: the potential role of sustainable forest management
MARIELOS PENA-CLAROS, Associate Professor, Wageningen University

The conservation of tropical forests depends largely on the fate of tropical forests managed for timber and other products, since the area of forests in protected areas is limited. Sustainable forest management has been proposed as a conservation strategy for tropical forests, with the idea that forests that are not managed sustainably will eventually lose their economic and ecological value and are likely to be converted to non-forest land uses. Many ecological questions about the implementation of this strategy remain, however, unanswered. In this presentation I first evaluate the impact of selective logging on biodiversity, forest dynamics, and ecosystem services. Then I highlight some silvicultural treatments that aim to improve growth of timber trees (such as liberation from lianas and other competing trees), to increase regeneration of commercial species, and to speed up forest recovery. Finally, I argue that ecological knowledge is key to define best management practices for tropical forests, and therefore that ecologists can - and need to - play a more active role in making management practices ecologically sound and environmentally sustainable.

Plenary Session 6
Thursday 23 June / 13:30-14:30 – Pasteur

The future role and key challenges of biodiversity conservation and use in Africa
TUYENI MWAMPAMBA, Researcher, UNAM-CIEco

Conservation success and sustainable use of biodiversity in Africa does not only depend on the coming together of sound science, appropriate policies and political will. It also depends on whether a shared vision can be carved between stakeholders, and whether a respectful pathway to viable solutions can be negotiated. Huge ideological gaps exist between local people, the conservation community and governments, however, and global interests and ideologies percolate into bottom-up approaches making it difficult to decipher a 'local' character in the solutions proposed. Yet, everywhere on the continent are inspiring examples of conservation science, training and practice done 'the African way' and situations begging us to think outside the box. Based on personal experience and interviews with conservation friends and colleagues in Africa, this talk will highlight the challenges we've faced while trying to do conservation work on the ground and while training the next generation of conservation scientists and practitioners. I will use this opportunity to showcase the unsung heroes who are setting the pathway for a different kind of conservation in Africa and who inspire us on a daily basis. This talk will hopefully convince you that there is hope for sustainable use and long-term maintenance of Africa's ecosystems, but that success will require a mixed bag of interventions and a double-take on how we conceptualize conservation 'problems' and design viable solutions.

O1-01 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Hunting wildlife: out of the frying pan and into the fire?

KATHARINE ABERNETHY[1], LAUREN COAD[2], JOHN FA[3], CARLOS PERES[4]
[1]University of Stirling, Tropical Ecology and Conservation Forum, FK9 4LA, Stirling, UK
[2]Oxford University, Centre for Environment, OX1 3QY, Oxford, UK
[3]Manchester Metropolitan University, Division of Biology and Conservation Ecology, M1 5GD, Manchester, UK
[4]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

The ancestors of hominids began to hunt wildlife in Africa many millennia ago. Their descendants have enjoyed such success that they are now the apex predators of all ecosystems across the globe.
Human hunting does not usually functionally replicate the predatory behaviour of other species lost from an ecosystem. Since prehistory, human hunting has driven primary targets; large-bodied species (mammals and birds), to widespread endangerment or extinction, and also taxa from other groups. Extensive contemporary efforts to assess the sustainability of modern hunting, particularly in tropical systems, indicate that most hunting is currently being conducted at unsustainable levels for the prey species.
Available evidence suggests that ecosystems are severely and extensively altered by the removal of species, which can cause irreversible changes in interspecific relationships. Cascading changes can be initiated in a trophic web by the loss of an apex predator, but lateral changes that ripple through an ecosystem can be produced when any species' function within it is lost; even species low in the trophic web.
For tropical forests, little is actually known of interspecific biotic control on populations beyond the apex predator. Where humans have replaced the apex predators, how do wildlife communities respond?
In this paper, we review the current state of knowledge of hunting pressure, focussing on tropical zones and highlighting the extent to which wildlife community change has been assessed. Focussing on the Congo and Amazon basin forests, we assess the drivers of hunting and how different human motivations affect the choice of prey, the intensity of hunting and the point at which hunting for a particular species becomes unsustainable for prey or for hunter. Through analysis of known outcomes from hunting communities that have already lost prey resources, we evaluate the possible futures for people and wildlife communities within the forests of the Congo and Amazon Basins, and discuss how improving our understanding of realistic defaunated future scenarios can change current conservation paradigms in tropical forests.

O1-02 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Influence of frugivore taxa on the generation of plant recruitment foci and on the composition of plant recruits' communities

FRANCK TROLLIET[1], PIERRE-MICHEL FORGET[2], JEAN-FRANÇOIS GILLET[3], JEAN-LOUIS DOUCET[3], ALAIN HAMBUCKERS[1]
[1]Université de Liège, Département Biologie, Ecologi, Evolution. Behavioral Biology Unit, 4000, Liège, Belgium
[2]Muséum National d'Histoire Naturelle, Département Ecologie et Gestion de la Biodiversité. UMR 7179 MECADEV CNRS-MNHN, 91800, Brunoy, France
[3]Université de Liège, Gembloux Agro-Bio Tech, Laboratoire de Foresterie des Régions tropicales et subtropicales, Unité de Gestion des Ressources forestières et des Milieux naturels, 5030, Gembloux, Belgium

Frugivores can disperse seeds in a spatially contagious pattern and generate recruitment foci (e.g. under fruiting trees). This process is increasingly explored to understand the influence of frugivores on the spatial organization of plant communities, and can also serve as a method to efficiently monitor the consequences of animal extirpation. However, there is limited evidence contrasting the influence of different frugivores taxa on the creation of recruitment foci under fruiting trees, and, similarly, on the overall composition of plant communities.
Here, we aimed (i) to compare the role of hornbills and primates in creating recruitment foci, and (ii) to investigate how the presence of hornbills, primates and elephants influence the overall composition of plant recruit's community in an anthropized forest-savanna mosaic in DR Congo.
We firstly compared the community of recruits (0.5-2 m high) in 25-m² plots below hornbill-dispersed trees (Staudtia kamerunensis, N=32), primate-dispersed trees (Dialium spp., N=26), and in control plots located below other tree species (N= 4900 m²). Secondly, we considered all plots to compare the community of recruits in five sites characterized by contrasted levels of hunting and housing different seed disperser communities.
Our preliminary results indicate (i) communities of recruits below hornbill-dispersed trees are significantly more dense and richer than in control plots, unlike these below primate-dispersed trees. Also, (ii) recruits in sites less affected by hunting, housing more large frugivores, including elephants, tend to belong to species with longer seeds.
We conclude that hornbills generate recruitment foci under fruiting trees, which can serve as an efficient tool to monitor the ecological consequences of their extirpation. Moreover, we discuss the potential influence of the different studied frugivore taxa and the risk of their extirpation from afro-tropical forests on the composition of plant recruits' community.

O1-03 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

The effects of hunting and competition on germination and survival among tropical tree seedlings

EDU EFFIOM[2], GABRIELA NUNEZ-ITURRI[3], OLA OLSSON[1], LAURA DIAZ[1], HENRIK SMITH[4]
[1]Lund University, Biology, 22362, Lund, Sweden
[2]Forestry Commission, Biodiversity, 234, Calabar, Nigeria
[3]University of Illinois, Biological Sciences, 61820, Chicago, USA
[4]Lund university, Centre for Environmental and Climate Research, 22362, Lund, Sweden

Background: Competition is widely believed to play crucial role in structuring plant communities, however, in the last decade it has been argued that competition may be irrelevant in controlling seedling regeneration in stressed hyper-diverse tropical forests where various mortality agents and mechanisms influence seedling survival. This is illustrated in a previous study where we found that community-wide seedling regeneration in an Afrotropical rainforest in Southeastern Nigeria is strongly affected by the loss of important seed dispersers.
Method: In three pairs of sites with very similar mature tree composition but with reduced (hunted sites) and intact (protected sites) large seed-dispersing fauna we tested the effect of inter-seedling competition on seedling germination and survival. We used three treatments (1st treatment (cleared plot): all seedlings were identified and tagged, 2nd treatment: all vegetation was cleared, 3rd treatment (selectively cleared plots): only primate dispersed seedlings were removed) aimed at manipulating the effect of competition among seedlings. Assuming that competition among seedlings is important, we hypothesized that the difference in germination between control and cleared plots should be large for weak competitors (abiotically-dispersed species) but less for the stronger (primate-dispersed species).
Results: We found higher germination of abiotically-dispersed species only in cleared plots in hunted sites and not in the cleared plots in protected sites. This was similar to what was obtained in the selectively cleared plots.
Discussion and Conclusion: Results indicate that competition may be irrelevant to seedling recruitment but rather human-induced disturbances like hunting and dispersal limitation are strong in structuring tropical plant communities.

O1-04 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Functional traits among tropical tree seedling communities shift in response to hunting

OLA OLSSON[1], EDU EFFIOM[2], LINDA ROSLUND[1], DANIEL OTU[3], FRIDA SIMONSSON[1], YANN CLOUGH[1]
[1]Lund University, Biology, 22362, Lund, Sweden
[2]Cross River State Forestry Commission, REDD unit, n/a, Calabar, Nigeria
[3]University of Jos, Forestry and Wildlife, n/a, Calabar, Nigera

The overhunting in tropical forests and the associated disappearance of large seed dispersers is causing a shift in the tree species composition as apparent from changes in the seedling layer. In hunted sites, primate dispersed species give way to species with other dispersal modes. It has been hypothesized that these changes are non-random with respect to important leaf and wood traits due to their correlation with the animal disperser-dependence of the species. We provide a test of this hypothesis by analyzing the relationship between response to hunting at the seedling stage and two leaf traits (leaf nitrogen concentration, and leaf mass per area) as well as a wood trait (stem specific density) of trees in an tropical moist forest in Nigeria. The leaf-traits are themselves negatively correlated, as expected from the leaf economics spectrum. We find that tree species that respond negatively to hunting typically have thick and heavy leafs with low nitrogen content, and those that benefit from hunting have the opposite leaf-traits. That is, species that benefit in defaunated forests have traits towards fast turnover rates. However, the effects are not linear, and should probably be interpreted with some caution. Stem-specific density increases rather than decreases with increasingly positive response to hunting, as many timber trees in these forests are abiotically dispersed. Beyond the dramatic effect of hunting of large animals on the conservation and cultural value of these forests, our results demonstrate shifts in functional traits indirectly related to hunting. This may significantly alter ecosystem functioning and the composition of future tree communities in these forests.

O1-05 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

The consequences of defaunation on the tree-frugivore network in Central African forests

BRETAGNOLLE FRANÇOIS[1], FORGET PIERRE-MICHEL[2], FONTAINE COLIN[3]
[1]University of Burgundy, UMR CNRS-UB 6282 Biogéosciences, 21000, Dijon, France
[2]MNHN, UMR 7179 MECADEV CNRS-MNHN, Muséum National d'Histoire Naturelle, 91800, Brunoy, France
[3]CNRS, UMR 7204 MNHN – CESCO, CNRS, 75005, Paris, France

Background: Although many tree species depend on animal for seed dispersal in tropical forests, the global tree-frugivore network in Central African and its regional variations have been poorly investigated. Moreover, the network organization (the way in which interactions are structured in the community) but also the quantitative aspects of the interactions (the seed dispersal effectiveness of the species) are important characteristics that needs to be measured to evaluate how forest tree biodiversity will be affected under global change forcing.
Method: We have compiled published literature and grey sources from different sites of Central Africa to construct the global tree-frugivore network in Central African forests. From this literature review we were also able to provide some proxies of the role of frugivorous species as seed dispersers, and to construct the local network in different study sites were a huge sampling effort have been realized.
Results: The analysis of the interaction network shows that big frugivorous species (elephant, apes) have a great influence on network organization and are the only species that can swallow the largest seeds. We found also a small redundancy among group of dispersers (elephant, apes, small monkeys, birds…). Some variation in the network were found depending on the site although the origin of such variation were not considered in the present study. However, a huge discrepancy on the knowledge of the contribution of the vertebrate groups to dispersal exists. The contribution of some groups such as frugivorous bats and birds still remains poorly known.
Conclusion: This preliminary qualitative and quantitative network needs to be improved. However, our results show that species contributing the most to the network organization are at the higher risk of extinction due to over hunting. The consequence of the plight of these species on the organization of the plant-frugivores interaction network is tremendous. Finally, the consideration of the complex frugivore-mediated seed dispersal is necessary to understand how tree biodiversity of these forests will change in the anthropocene.

O1-06 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Parallel impacts of defaunation over seed removal by frugivores and dung beetle communities in a tropical rain forest

OLIVIER BOISSIER[1], FRANÇOIS FEER[1], AURÉLIE ALBERT[2], AXELLE BOUIGES[3], IRENE MENDOZA[4], PIERRE-MICHEL FORGET[1]
[1]Muséum National d'Histoire Naturelle, Paris, Département Ecologie et Gestion de la Biodiversité, 91800, Brunoy, France
[2]Kew Royal Botanic Gardens, Comparative Plant and Fungal Biology, TW9 3AB, Richmond, United Kingdom
[3]Muséum National d'Histoire Naturelle, Paris, Département Systématique et Evolution, 75005, Paris, France
[4]Universidade Estadual Paulista, Departamento de Botânica, 13506-900, Rio Claro, Brazil

Communities of large tropical forest vertebrates worldwide are being severely depleted by bushmeat hunting. The cascading effects of this defaunation process on ecological processes have been individually studied for some time. But only rarely have multiple impacts of defaunation been investigated simultaneously over the same sites. Here we focused on two different consequences of defaunation over five sites in French Guiana: its effects on seed dispersal and on dung beetle communities. Seed dispersal is a key stage in the reproductive cycle of tree species and is essential to forest regeneration, while dung beetles provide key ecosystem services such as nutrient cycling, soil bioturbation or secondary seed dispersal. Our study spanned six years, from 2009 to 2015, over five sites: one protected and remote site with intact mammal and bird communities (Nouragues), two sites with road access and intermediate levels of defaunation (Montagne de Kaw and Saint-Georges) and two sites with close proximity to urban areas and high levels of defaunation (Matoury and Rorota). Effects of defaunation on seed removal were investigated on two endozoochorous tree species: Virola michelii and V. kwatae (Myristicaceae). Numbers of fallen fruits and seeds were counted within one-square-meter quadrats placed underneath fruiting trees in order to calculate the proportion of seeds removed. Seed removal rates decreased along the gradient of defaunation, from 84% at Nouragues to 70% and 65% at the sites of intermediate disturbance, and significantly dropped to 22% and 28% at the most heavily defaunated sites. Communities of coprophagous beetles (Scarabaeinae) were surveyed over the same sites using pitfall traps. Estimated species richness decreased along the gradient of defaunation, significantly so for the most impacted sites. Diversity and abundance of diurnal genera of large tunnellers, the most resource-sensitive species, were highest at Nouragues and lowest at the most disturbed sites. Finally, the presence of one medium-sized species, dominant at the most disturbed sites while it was absent at the intact site, was another indicator of forest disturbance. Seed removal and species richness and structure of dung beetle communities thus showed similar evolutions along the gradient of disturbance. Both can be considered as indicators of defaunation and are just two examples of the myriad cascading effects of defaunation in tropical forest ecosystems.

O1-07 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Functional transitions in tree assemblages in semi-defaunated forest islands following 26 years of isolation

CARLOS PERES, MAIRA BENCHIMOL, ISABEL JONES
[1]University of East Anglia, School of Environmental Sciences, NR47TJ, Norwich, UK
[2]Universidade Estadual de Santa Cruz, Department of Ecology, 45662-900, Ilheus, Brazil
[3]University of Stirling, Department of Biological and Environmental Sciences, FK94LA, Stirling, UK

(St)age transitions in tropical plant communities and their ecosystem services depend on patch-scale occupancy and abundance of effective seed dispersal agents, which in neotropical forests are vastly dominated by vertebrates. These transitions are best investigated at multiple habitat patches where assemblages of small-, medium- and large-bodied frugivores-- that ingest different size spectra of viable seeds -- has been predictably eroded. We examined patterns of faunal and floristic composition and abundance within 36 variable-sized land-bridge islands and three continuous forest sites within the 443,700-ha Balbina Hydroelectric Dam landscape of Central Brazilian Amazonia. We surveyed all bird and mammal species >500 g at all forest sites using four sampling techniques − line-transect censuses, sign surveys, armadillo burrow counts and camera-trapping, and identified to species level all live trees ≥10 cm DBH and saplings (<2cm DBH and >1m in height) within a total of 89 quarter-hectare forest plots. We then examined the structure of inferred fruit-frugivore networks and patterns of community drift for five functional groups of tree species across all forest sites for which the composition and density of the frugivore coterie was known. Species abundance transitions from adult trees to saplings reveal a significant effect of the predicted patterns of seed-dispersal strength for different tree guilds, particularly in terms of dispersal mode. Our results suggest a number of negative feedback loops that set in motion a sequential erosion of mutualistic networks and functional diversity of insular forests well beyond those predicted by unstructured species-area effects.

O1-08 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Importance of animal and plant traits for fruit removal and seedling establishment in a tropical forest

MARCIA CAROLINA MUNOZ[1], H. MARTIN SCHAEFER[3], KATRIN BÖHNING-GAESE[2], MATTHIAS SCHLEUNING[1]
[1]Senckenberg Biodiversity and Climate Research Centre (BiK-F), Biodiversity and Area Dynamics of Vertebrates, 60325, Frankfurt am Main, Germany
[2]Goethe Universität, Department of Biological Sciences, 60438, Frankfurt am Main, Germany
[3]University of Freiburg, Department of Evolutionary Biology and Animal Ecology, 79104, Freiburg, Germany

Background: The traits of animals and plants influence their mutualistic interactions in networks, but the significance of species traits for the resulting ecosystem functions is poorly understood. A crucial ecosystem function in the tropics is seed dispersal by frugivorous animals. No study has so far identified the functional traits determining the subsequent processes of fruit removal and plant recruitment.
Method: We conducted a comprehensive field study on fruit removal by frugivorous birds and seedling establishment along an elevational gradient in the Colombian Andes. We measured morphological traits of birds (body mass, bill width, Kipp´s index) and plants (plant height, crop mass, fruit length and seed mass) which we expected to be related to fruit removal and plant recruitment. We tested 1) which bird and plant traits influence fruit removal, and 2) whether network metrics, functional identities of frugivores (community-based trait means) and/or plant traits were the main determinants of plant recruitment.
Result: We found that large-bodied bird species contributed more to fruit removal than small-bodied birds and that small-sized fruits were more frequently removed than large-sized fruits. In contrast, small plant species and plants with large seeds recruited more seedlings than did large plants and plants with small seeds. Network metrics and functional identities of seed dispersers were unrelated to seedling recruitment.
Discussion: Our findings have two important implications. First, large bird species are functionally more important than small birds in tropical seed-dispersal networks. Second, the trade-off between fruit size and seed mass in subsequent recruitment processes suggests that the adaptability of plant communities to a loss of large frugivores is limited by life-history constraints. Hence, the protection of large-bodied frugivores is of primary importance for the maintenance of diverse tropical plant communities.

O1-09 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Large herbivores modulate vegetation communities and net primary productivity in tropical forests

NACHO VILLAR[1], FABIANA ROCHA-MENDES[1], MAURO GALETTI[1], ROGER GUEVARA[2]
[1]Universidade Estadual Paulista (UNESP), Departamento de Ecologia, 13506-900, Rio Claro, Brazil
[2]C. Red de Biología Evolutiva, Instituto de Ecología, 91000, Veracruz, Mexico

In tropical forests, defaunation of large mammals is one of the major threats to biodiversity, yet the extent and mechanisms of top-down control by large mammalian herbivores on tropical vegetation communities remains poorly investigated. Here we test experimentally the top-down effects of large mammalian herbivores on plant communities in two tropical rainforest sites with contrasting levels of defaunation. Using a replicated experimental design with 15 paired herbivore access (open) and herbivore exclosure plots per site, we measured how plant recruitment, species richness, diversity, and aboveground net primary productivity (ANPP) responded to herbivory. We measured herbivore activity through trampling, and a set of micro-habitat descriptors at every exclosure-control pair location. We used generalized linear mixed-effects models to test the response of vegetation to the interactive effects of herbivory, defaunation and micro-habitat characteristics. We found strong evidence of both positive and negative top-down control of large mammalian herbivores on vegetation communities. Large herbivore activity increased strongly with the density of Euterpe edulis palms so that the density of this key resource mediated the impact of herbivores. In non-defaunated locations with high density of palms, open plots held twice as many plant species and recruited substantially more plants than exclosures. Furthermore, ANPP increased by orders of magnitude with large herbivore activity if density of palms was high. In contrast, at non-defaunated locations where palm density was low the impact of large mammalian herbivores was negative. In the defaunated forest we found few changes in species richness, recruitment and a strong negative impact of trampling on ANPP regardless of habitat descriptors or palm density. Plant diversity did not change in response to herbivore exclusion, defaunation or micro-habitat characteristics. These results demonstrate that large mammalian herbivores modulate vegetation communities and net primary productivity at the landscape scale in tropical forests as a result of positive or negative top-down control that depends on microsite characteristics. The collapse of these herbivores from many tropical forests is likely having a substantial impact in key ecosystem processes and services including vegetation community composition and dynamics, and the regulation of net primary productivity and carbon sequestration.

O1-10 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Hunting-induced defaunation causes long-term shifts in tree community composition

JOHN TERBORGH[1], KIRSTIE HAZELWOOD[2], FERNANDO CORNEJO[3], ELIZABETH PRINGLE[4], HARALD BECK[5]
C. E. TIMOTHY PAINE[2]
[1]Duke University, Center for Tropical Conservation, 27705, Durham, United States
[2]University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, United Kingdom
[3]Lima, Peru, 15087, Lima, Peru
[4]Max Planck Institute for Chemical Ecology, Department of Biochemistry, 07745, Jena, Germany
[5]Towson University, Department of Biological Sciences, 21252, Towson, United States

Animals play an important role in shaping plant communities through seed dispersal and predation, but in many tropical regions large vertebrates are being extirpated through hunting. When this guild of animals is removed these functions are effectively lost from the ecological community, with severe consequences for the plant community. To assess the impacts of defaunation in a tropical tree community, we surveyed two sites in the Rio Manu floodplain in south-eastern Peru, one site with intact fauna and one with a severely depleted large vertebrate community. By comparing the sapling and adult tree communities at the two sites over a period of 11 years we detected substantial directional changes in tree community structure.

These changes can be seen in the range of dispersal mechanisms within each community; species that rely on large vertebrates as a main disperser are expected to show lower recruitment rates at a site where large vertebrates are removed. These species are likely to be replaced by species that rely on smaller vertebrates or abiotic means for dispersal. The sapling communities showed a marked difference between the two sites, with new recruits at the intact site spread evenly over the different dispersal syndromes and the sapling recruits at the hunted site shifting towards species that rely on bats, birds and abiotic means for dispersal. There was no difference between the adult tree communities at the two sites, as expected, since most of these trees predate the arrival of hunting in the area.

There will be severe long term consequences from this slowly changing forest structure, with overall biodiversity loss in the faunal and floral community over large parts of the tropics. In tropical regions where hunting continues to deplete large fauna populations, plant species composition will be irreversibly altered. It is likely now that these are the forests of our future, and our understanding of these forests and their protection is rooted in our understanding of this long term directional change and the causes driving this change.

O1-11 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Consequences of defaunation for wood density and carbon storage in a tropical forest

ELIZABETH PRINGLE[1], TALITHA FERREIRA DOS SANTOS[2], MARCELLE GONÇALVES[2], CARLOS PERES[3], FABRICIO BACCARO[2]
[1]Max Planck Institute for Chemical Ecology, Department of Biochemistry, 07745, Jena, Germany
[2]Universidade Federal do Amazonas, Department of Biology, 69077, Manaus, Brazil
[3]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

Human hunters in Neotropical forests preferentially forage for large-bodied mammals, including arboreal frugivores and terrestrial seed predators. These animals play key roles in the seed-to-seedling transition of local trees, and this transition helps determine tree community structure. The local extirpation of animals from hunting should thus shift the relative species abundances of recruiting saplings, causing long-term changes in the species composition of the adult tree layer. If defaunation favours the recruitment of small-seeded species and there is a correlation between seed size and wood density, intensive hunting could also affect forest carbon storage. In particular, defaunation could lead to a net decrease in wood density, reducing the potential of tropical forests to store carbon. Using an unprecedentedly detailed dataset, we tested this hypothesis.

We compared the sapling and adult tree communities at two sites in the Rio Manu floodplain in south-eastern Peru, one with an intact fauna and one from which all diurnal large-bodied mammals have been effectively extirpated. Censuses of saplings and adult trees were performed in 2004, 2009 and 2015. We also assessed sapwood density by water displacement for up to three individuals of 300 tree species, representing more than 90% of the stems at both sites. We applied species-mean sapwood densities to all conspecific saplings and adults.

At the time we were writing this abstract, preliminary results suggested that the sapling layer had lower wood density than the adult trees at the hunted site, but not at the un-hunted site. Changes in relative species abundances caused by defaunation may thus have important consequences for ecosystem services. If the species that recruit preferentially in the hunted site grow no larger than those they displace, hunting will cause a significant long-term decrease in the carbon storage of this forest. Given that anthropogenic hunting is pervasive in tropical forests around the world, it has the potential to cause significant long term decreases in aboveground carbon storage, with substantial effects on global carbon cycling.

O1-12 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Carbon loss induced by large frugivores defaunation and its relations with landscape structure

CAROLINA BELLO[1], MAURO GALETTI[1], LUIZ FERNANDO S. MAGNAGO[2], MARIANA F. ROCHA[2], RENATO LIMA[3], CARLOS A. PERES[4], MARCO A. PIZO[5], SEBASTIÃO V. MARTINS[6], OTSO OVASKAINEN[7], PEDRO JORDANO[8]
[1]Universidade Estadual Paulista, Departamento de Ecologia, 13506-900, Rio Claro, Brazil
[2]Universidade Federal de Lavras, Departamento de Biologia, Setor de Ecologia e Conservação, 37200-000, Lavras, Brazil
[3]Universidade de São Paulo, Departamento de Ecologia, 05508-900, Sao Paulo, Brazil
[4]University of East Anglia, School of Environmental Sciences, NR47TJ, Norwich, United Kingdom
[5]Universidade Estadual Paulista, Departamento de Zoologia, 13506-900, Rio Claro, Brazil
[6]Universidade Federal de Viçosa, Departamento de Engenharia Florestal, 36570-900, Minas Gerais, Brazil
[7]University of Helsinki, Department of Biosciences, FI-00014, Helsinki, Finland
[8]Estación Biológica de Doñana, Integrative Ecology Group, E-41092, Sevilla, Spain

Background: Fragmentation, logging, edge effects showed impacts on carbon stocks, however an elusive and undetected change is the effects of defaunation of large frugivores. Many tropical trees with a large contribution to carbon stock rely on large frugivores for seed dispersal, most of them being threatened specially in fragmented forest.

Method: We quantified the indirect effect of defaunation of large-bodied frugivores on carbon storage by analyzing a large dataset of tree species composition and traits of the Atlantic forest. We explore the relations between fruits and carbon traits for 2014 species. We simulated the extinction of trees that depends of large frugivores in 31 conserved communities to explore the effect in the carbon storage capacity. We built two extinctions scenarios: A random extinction scenario and a defaunated scenario. Then, we compare the carbon stock in the initial and in the final communities. Finally, we explored its relation with the landscape structure. We sample a landscape composed by 9 forest fragments and two control forest larger than 20000 ha. In each fragment we sampled trees in the edge and in the interior. For each fragment we applied the same simulations and relate the carbon loss with landscape, microclimate, soil and compositional features.

Result: We show that the extinction of large frugivores could lead a erosion of carbon storage in tropical forests. We found a strong correlation between seed diameter and wood density ($r=0.28$, $P <0.001$) and height ($r=0.25$, $p < 0.001$). We observed a greater loss of carbon as the percentage of removed large-seeded tree species increases, as a consequence of defaunation of large frugivores. Moreover, we found that this carbon loss is enhanced by the landscape structure. We found that defaunation is more likely to reduce carbon stocks in forest interiors than in edges; isolated fragments are more vulnerable; and that all fragment sizes can have carbon losses by defaunation impacts.

Discussion: Our result highlights the fragility of carbon storage under the current defaunation process. Halting defaunation will not only save charismatic animals but also have effects on climate change, carbon markets, and reforestation processes. We emphasize that defaunation effects can occur principally in interiors and in isolated forest. Therefore, restoration and REDD+ programs should include biotic interactions and landscape configurations to guarantee carbon storage in the long term.

O1-13 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

Natural born gardeners – extant tortoises to fight defaunation?

PATRICK O. WAEBER[1], LUCIENNE WILMÉ[2]
[1]Swiss Federal Institute of Technology Zurich, Environmental Sciences, 8092, Zurich, Switzerland
[2]University of Antananarivo, School of Agronomy, 101, Antananarivo, Madagascar

Rewilding is widely used for ecosystem restoration through the (re-)introduction of species. This has been applied in the Seychelles in the late 1970s, more recently in the Mascarenes and is proposed in Madagascar with the introduction of the Aldabra giant tortoise Aldabrachelys gigantea. On Îles aux Aigrettes (Mauritius) the very same tortoise has been introduced in 2000. Long term studies showed the positive impact of the tortoise in the germination success and dispersal of the endemic ebony tree species Diospyros egrettarum (Ebenaceae). Giant tortoises, Cylindraspis spp., were found on many remote islands in the Indian Ocean at the time the European discovered these islands (late 1500s). For colonization to have occurred by dispersal, giant tortoises must either have originated in Madagascar or Africa and swum for hundreds of km against the ocean currents, or have launched themselves from the eastern Indian Ocean margin to drift with the currents over several thousands of km of open sea. After these navigational feats, the land tortoises would have needed to found new, viable populations on potentially inhospitable volcanic or coral outcrops. The geology, sea level changes (that must have eliminated all terrestrial life from islands such as Aldabra) in recent times, the ocean currents, and our understanding of the life history traits of tortoises make it very difficult to accept an accidental colonization of these remote islands. Studies on species' biogeography should consider a possible contribution of pre- and protohistoric human activities to species distributions as documented for the European discoverers. The current ecological systems encountered in southwestern Indian Ocean have evolved and changed since human landed on the islands some 4000 years ago. As of today, however, it remains unclear when they arrived, when they settled, and especially which species they have introduced or translocated. Rewilding should be considered with caution and not be seen as a 'panacea for conservation'.

O1-14 – S1 *Defaunation: a local process with global implications*
Monday 20 June 20 / 11:00-17:30 – Pasteur

A modeling approach to study the role of megafauna in tropical forest dynamics

FABIO BERZAGHI[1], HANS VERBEECK[2], FRANÇOIS BRETAGNOLLE[3], CHRIS DOUGHTY[4], MARCO MARCHETTI[5], GIUSEPPE SCARASCIA-MUGNOZZA[1]
[1]University of Tuscia, aDepartment for Innovation in Biological, Agro-food, and Forestry Systems, 01100, Viterbo, Italy
[2]Ghent University, Faculty of Bioscience Engineering, 9000, Gent, Belgium
[3]Université de Bourgogne, eLaboratoire Biogéosciences, 21000, Dijon, France
[4]University of Oxford, School of Geography and the Environment, 0X13QY, Oxford, United Kingdom
[5]University of Molise, Department of Bioscience and Territory, 86090, Pesche, Italy

Large herbivores in tropical forests directly and indirectly impact forest structure, function, and carbon cycling through browsing, seed dispersal, seed predation, and nutrient cycling. It has been shown that the loss of large bodied animals caused by hunting can negatively impact animal dispersed plants, while it might benefit fast growing, wind dispersed species. However, some studies have presented opposing evidence or have not detected significant differences in forest structure and species composition following the extirpation of large herbivores. These contrasting results might be caused by different methodologies, environmental variability, and variable length in vegetation sampling. In particular, studies of limited duration might only capture the first phase post disturbance. From a different perspective but with similar implications, emerging evidence is suggesting that the extinction of most megafauna from South America (roughly 10K YBP) might have contributed to some of the structural differences between Amazonian and African tropical forests. All these findings are pointing to the hypothesis that megafauna might ultimately be linked to forest carbon stocks. Forests with higher carbon content could be the result of two processes linked to megafauna: (1) Megafauna-dispersed trees with large seeds have on average higher wood density, when megafauna-trees lose their primary dispersal agent they become less abundant and are replaced by softer trees. (2) Megafauna might reduce the understory and increase resource availability for dominant trees to grow more and assimilate more carbon. To test some of these hypotheses, we employ a mechanistic forest model driven with realistic environmental data, validated with forest inventories, and calibrated according to plant-animal studies. We examine the effects of megafauna on forest structure and carbon cycling in a modeling environment where we can overcome some of the limitations of field studies and simulate long-term changes over many tree generations. We present the results of some of our simulations and discuss challenges and possible improvements to our approach.

O2-01 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

Patterns of niche evolution across the legume phylogeny and their relevance for understanding the historical assembly of neotropical biomes

R. TOBY PENNINGTON[1], KYLE DEXTER[2], DANILO NEVES[3], TIM BAKER[4], ARY OLIVEIRA-FILHO[5], LUCIANO DE QUEIROZ[6], COLIN HUGHES[7], ERIK KOENEN[7], ANNE BRUNEAU[8], DOMINGOS CARDOSO[9], MARTIN WOJCIECHOWSKI[10], HAROLDO DE LIMA[1]
[1]Royal Botanic Garden Edinburgh, Science, EH3 5LR, Edinburgh, UK
[2]University of Edinburgh, GeoSciences, EH9 3FF, Edinburgh, UK
[3]Royal Botanic Gardens, Kew, Herbarium, TW9 3AB, Richmond, Surrey, UK
[4]University of Leeds, Geography, LS2 9JT, Leeds, UK
[5]Universidade Federal de Minas Gerais, Departamento de Botânica, 31270-901, Belo Horizonte, Brazil
[6]Universidad Estdual de Feira de Santana, Biological Sciences, CEP 44036-900, Feira de Santana, Brazil
[7]University of Zurich, Institute of Systematic Botany, 8008, Zurich, Switzerland
[8]Université de Montréal, Institut de recherche en biologie végétale, H1X 2B2, Montreal, Canada
[9]Universidade Federal de Bahia, Departamento de Botânica, 40170115, Salvador, Brazil
[10]Arizona State University, School of Life Sciences, AZ 85287 - 4501, Tempe, USA
[11]Jardim Botano do Rio de Janeiro, Instituto de Pesquisas, 22460-030, Ro de Janeiro, Brazil

Background – Legume trees dominate the major lowland biomes of the Neotropics, including rain forests, seasonally dry tropical forests (SDTF) and savannas. Legumes therefore play a key role in the functioning of diverse ecosystems. Phylogenetic evidence for a few legume clades suggests a pattern of phylogenetic biome conservatism in SDTFs but in other clades, wet and dry forest lineages have switched to the savanna biome frequently, suggesting lesser biome conservation. We analyse a phylogeny that samples tree species across the entire legume family in order to understand how patterns of biome-switching and climatic niche evolution underpin the success of legumes more generally.
Methods – Using the plastid gene matK, with more variable markers providing resolution in some species-rich genera, we have developed a phylogeny that covers c ~900 species of woody legumes found in ~2000 inventory plots across the major biomes of lowland tropical South America. We use this phylogeny to estimate the frequency of shifts amongst major biomes and to quantify climatic niche evolution.
Results – Rates of climatic niche evolution seem to be correlated with rates of species diversification across legume genera, so clades that shift their climatic niche more often may contain more species. Our preliminary results suggest, however, that rates of niche evolution are not correlated with the ecological abundance of clades, so evolutionary niche lability does not necessarily translate into ecological dominance.
Discussion – We will discuss the challenges of untangling patterns of evolutionary biome switching and niche evolution across all tropical legumes, not just trees. This will require a phylogeny for all c. 19,500 legume species and a much better understanding of edaphic factors that are suspected to be key ecological determinants of legume distributions in the tropics.

O2-02 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

All legumes are not equal: understanding legume dominance across the tropics

Caroline LEHMANN[1], Abigail CABRELLI[1], Kyle DEXTER[1], Toby PENNINGTON[2]
[1]University of Edinburgh, School of GeoSciences, EH93FF, Edinburgh, Scotland
[2]Royal Botanic Garden Edinburgh, Tropical Diversity, EH35LR, Edinburgh, Scotland

Background: Legumes (Leguminosae or Fabaceae), which evolved 60 million years ago, are one of the most diverse and ecologically successful families of flowering plants, and woody legumes are a particularly important component of many tropical biomes. Legumes are well known for an ability to fix nitrogen via root symbioses, a key innovation in plant function over the evolutionary history of plants thought fundamental in explaining their ecological success. However, not all legume species are able to nodulate and fix nitrogen, and non-nodulating legumes are themselves a diverse and important group of plant species.
Methods: Via a synthesis of data from 1304 plot inventories across forests and savannas of tropical Africa, Australia, Asia and South America, and using Bayesian mixture modelling, we explore how N-fixation via nodulation is related to legume dominance across continents, biomes and the environmental gradients of rainfall, temperature and fire. We examined dominance both in terms of species richness and biomass (using tree basal area as a proxy for woody biomass).
Results: Legumes vary widely in their abundance and diversity across the tropics. On most continents, nodulating legumes dominate in savanna ecosystems, especially arid savannas, whose woody plants communities are comprised almost entirely of nodulating legumes. Africa shows the highest dominance of both nodulating and non-nodulating legumes. Although, in general, continent is the key predictor of the abundance of non-nodulating legumes.
Conclusions: We suggest that historical biogeography has a marked influence in the distribution of non-nodulating legumes, perhaps due to competitive exclusion by other, already established plant taxa in regions such as Australasia where Myrtaceae dominate. In contrast, we theorise that the functional innovation of nodulating legumes enables these taxa to dominate disturbance prone and arid systems where rapid rates of plant (re) growth facilitate competitive success. Nodulating legumes are less abundant in closed canopy forest environments, where legumes, while rich in species, do not show pervasive dominance of biomass.

O2-03 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

Temporal diversity dynamics of mimosoid legumes, a key ecological component of global tropical biomes

ERIK KOENEN[1], KYLE DEXTER[2], JENS RINGELBERG[1], ELVIA DE SOUZA[3], PRISCILLA DE ALMEIDA[4], JOÃO IGANCI[5], PÉTALA RIBEIRO[4], MARCELO SIMON[6], VANESSA TERRA[7], DONOVAN BAILEY[8], JAMES BOATWRIGHT[9], GILLIAN BROWN[10], JAVIER AJU[11], MICHELLE VAN DER BANK[12], JOE MILLER[13], LUCIANO DE QUEIROZ[4], TOBY PENNINGTON[14], COLIN HUGHES[1]
[1]University of Zurich, Institute of Systematic Botany, 8008, Zurich, Switzerland
[2]University of Edinburgh, School of Geosciences, EH9 3FE, Edinburgh, United Kingdom
[3]Universidade do Estado da Bahia, Departamento de Educa, 48608-240, Paulo Afonso, Brazil
[4]Universidade Estatal Feira de Santana, Departamenta de Ciências Biológica, 44036-900, Feira de Santana, Brazil
[5]Universidade Federal do Rio Grande do Sul, Instituto de Biociências, Departamento de Botânica, 91501-970, Porto Alegre, Brazil
[6]Empresa Brasileira de Pesquisa Agropecuária (Embrapa), Parque Estação Biológica, 70770-901, Brasilia, Brazil
[7]Universidade Federal de Uberlândia, Instituto de Ciências Agrárias, 38400-902, Uberlândia, Brazil
[8]New Mexico State University, Department of Biology, 88003, Las Cruces NM, USA
[9]University of the Western Cape, Department of Biodiversity and Conservation Biology, 7535, Bellville, Republic of South Africa
[10]Queensland Herbarium, Department of Science, Information Technology and Innovation, 4066, Brisbane, Australia
[11]University of Melbourne, School of Biosciences, 3010, Victoria, Australia
[12]University of Johannesburg, African Centre for DNA Barcoding, 2006, Auckland Park, Republic of South Africa
[13]National Science Foundation, Division of Environmental Biology, 22230, Arlington VA, USA
[14]Royal Botanic Gardens Edinburgh, Department of Science, EH3 5LR, Edinburgh, United Kingdom

Background – The mimosoid legumes (Leguminosae-Mimosoideae) are a pantropically distributed clade of c. 3300 species of large rainforest trees and lianas, savanna and seasonally dry forest trees and shrubs, and creeping and geoxylic fire-adapted subshrubs. They occupy a wide ecological amplitude spanning the whole lowland tropics and often constitute abundant or dominant elements in tropical rain forests, seasonally dry forests and savannas. Here we analyse the temporal origins and evolutionary dynamics of extant mimosoid diversity in modern tropical biomes, to gain insights into the origins of tropical biodiversity.
Methods – We construct the largest phylogeny for the group to date by adding densely sampled phylogenetic trees of subclades in a hierarchical fashion onto a well-resolved time-calibrated backbone phylogeny based on Next-Generation Sequencing (NGS) of plastid and nuclear genes. We correct for unsampled diversity by simulation and estimate speciation, extinction and net diversification rates across the phylogeny.
Results – While the clade dates back to at least the Early Eocene, most of the extant diversity is derived from later episodes of diversification from the Early Miocene onwards. Exceptionally high diversity is found in the genus Mimosa (c. 550 spp.) and in a large clade comprising the tribes Ingeae and Acacieae p.p. (c. 2000 spp.), which includes multiple nested radiations.
Discussion – We propose that the temporal diversity dynamics of mimosoid legumes are best explained by punctuated extinction and radiation, which leads to episodic species turnover through time. Our findings are important for a general understanding of the temporal assembly of floras, and indeed whole biotas across – and perhaps beyond – the global tropics.

O2-04 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

Tropical dry forest legumes aren't just different—they are better

Jennifer Powers[1], Erick Calderon[2], Maria Gabriela Gei[1], Christina Smith[1], German Vargas-G[1], Bonnie Waring[1]
[1]University of Minnesota, Ecology, Evolution & Behavior and Plant Biology, 55108, Saint Paul, USA
[2]Universidad Nacional, Escuela de Ciencias Biológicas, 86-3000, Heredia, Costa Rica

Background: Trees and lianas from the family Fabaceae are abundant and diverse in many Neotropical dry forests. Possible explanations for this pattern include biogeographic factors and/or traits that allow legumes to flourish under conditions of highly seasonal water availability. While it is well established that legumes typically have higher foliar nitrogen concentrations compared to co-occuring taxa, it is also possible that they differ in other ways. We asked whether legumes have traits that confer competitive advantages in tropical dry forest in northwestern Costa Rica, where legumes comprise ~18% of trees.
Methods: We used shadehouse experiments to compare germination, growth, morphology, and physiology of a large number of tropical dry forest legume tree and liana species to diverse, co-occurring non-legume species. In three experiments we manipulated germination treatment, light and soil conditions, or water and/or nutrient additions to compare legumes to non-legumes across a range of environmental conditions.
Results: In a germination experiment, legume seeds from 9 species germinated twice as fast and had higher final percentages than 25 non-legume species. Legume tree seedlings in a pot experiment with two light levels (25 and 50% full sun) on two soil types (fertile, wet soil versus infertile, dry soil) had higher height growth rates and final biomass, and were more responsive to light availability than 14 species of non-legumes from 11 different families. To distinguish whether soil water or nutrients are more important for early performance of legumes and non-legume seedlings, we grew four species of each in a common soil, and pots received added nutrients, water, both, or no additions. Photosynthetic rates of legumes were twice those of non-legumes, while transpiration rates increased with water addition, but did not differ between legumes and non-legumes. Height growth in legumes was much more responsive to added nutrients or nutrients plus water, compared to the non-legume taxa.
Discussion: These studies suggest that legumes have a distinct regeneration niche in this forest. They germinate and grow quickly. This initial height advantage is maintained over time. Moreover, legume seedlings are more responsive to variations in light, soil moisture, and soil nutrients compared to non-legumes. This may be an adaptive strategy in tropical dry forests, where resource availability varies dramatically between wet and dry seasons.

O2-05 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

Do anti-herbivore defenses facilitate dominance by legumes in tropical wet forests?

KURSAR THOMAS[1, 2]
[1]University of Utah, Department of Biology, 84112, Salt Lake CIty, USA
[2]Smithsonian Tropical Research Institute, Biology, 00006, Panama City, Panama

One factor that could explain the high abundance and high species diversity of legumes is superior defense against herbivores. A hypothesis that has received particular attention is that nitrogen fixation in legumes is linked to the production of N-containing toxins, including amines, alkaloids, peptides and proteins, that exceeds the abundance and diversity found in other clades.
Inga, a genus that is diverse and highly abundant and, as such, is emblematic of tropical forest legumes, may not fit this pattern. Aside from some exceptional species, diversity among the most abundant secondary metabolites is generated by combinatorial chemistry using building-block compounds that are widely distributed in plants and that do not contain nitrogen. Most, if not all, Inga contain low levels of derivatives of amino acids. Some species contain high levels of tyrosine, a proteogenic amino acid that is toxic, and peptides that inhibit proteases. Although some species of Inga do contain N-based defenses, it is not clear that these play a more critical role than the carbon-based defenses.
Rather than N-fixation, other traits of legumes could lead to ecological dominance. Genetic or genomic properties may allow more rapid trait divergence or more rapid speciation. For example, legumes may have rapid evolution of regulatory genes and much slower evolution of enzyme-coding genes. Or, legumes may evolve novel enzymes and metabolites, although it is unclear what genetic or genomic property might lead to this.
In addition to constitutive chemistry, other defenses include facultative mutualisms with ants and induced responses. Under field conditions on Barro Colorado Island, we studied induced responses to an herbivore in expanding leaves of Inga spp. and found limited evidence for chemical induction. Herbivory induces longer spines in Acacia, mechanical damage or herbivory induces secretion by extra-floral nectaries in some tropical forest legumes and Euphorbiaceae, although not for Inga. Although these data for tropical forest tress are quite limited, legumes do not stand out as being especially well defended.
In summary, although the evidence is limited, we suggest that legume dominance does not derive from superior defenses against herbivores.

O2-06 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

The legumes of a Mexican tropical dry landscape: a success story based on their high ecological divergence

JORGE A. MEAVE, EDUARDO A. PÉREZ-GARCÍA, RODRIGO MUÑOZ, I. EUNICE ROMERO-PÉREZ,
MARCO ANTONIO ROMERO-ROMERO
Universidad Nacional Autónoma de México, Departamento de Ecología y Recursos Naturales, Facultad de Ciencias, 04510, Mexico City, Mexico

Background: The tropical seasonally dry landscape of Nizanda (Mexico) hosts a rich flora that comprises > 900 vascular plant species in ca. 100 km^2. Such richness has been related to a complex geomorphology that creates steep soil fertility and moisture gradients. This results in a vegetational mosaic that encompasses major structural and compositional differences. Here we assess legume success in this landscape from floristic, functional and community perspectives.
Methods: For over 20 years floristic and ecological surveys have been conducted in this region. An insight on the role of its legumes relies on copious herbarium specimens, more than 250 vegetation sampling quadrats, and functional data measured at the individual level, including leaf morphology, growth form and wood density. Vegetation surveys include non-permanent and permanent plots, both for old-growth and successional forest.
Results: We found 129 legume species (14 % of the flora) distributed in 54 genera. They occur in most vegetation types but are most diverse in tropical dry forest (69 species). Legumes are a major community component in all stages of secondary forests, accounting for 81 % of the community basal area in young stands and 67 % in older ones; in old-growth forest they contribute with as much as 33 % of the total basal area and 45 % of aboveground biomass. Most taxa are trees, followed by shrubs, forbs, and lianas, and these growth forms are unevenly distributed across communities. Legumes also display huge differences in size, ranging from the smallest herbs like Zornia reticulata in savannas to large upper canopy trees like Lysiloma divaricatum. Leaf sizes range from notophylls and nanophylls to macrophylls, with sizable variation in leafleat size and degree of blade division.
Discussion: Despite phylogenetic constraints among legumes, such as the pervasive compound configuration of the leaf blade, members of this family exhibit a strong dominance in Nizanda's plant communities. Their occurrence in contrasting habitats, from the most xeric and least fertile to the benign conditions of the moist riparian environments, confirms their ecological breadth. Although we lack information on their N-fixing abilities or the photosynthetic rates under highly limiting water conditions, our results allow us to conclude that ecological divergence within the family is an important factor contributing to their success as a group in this complex landscape.

O2-07 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

Distribution of legumes across successional gradients in the Neotropics

MARIA G. GEI, JENNIFER S. POWERS
University of Minnesota, Ecology, Evolution and Behavior, 55108, St. Paul, United States

Background. Understanding the patterns of legume (Fabaceae) abundance and mechanisms that explain why legumes are so dominant in tropical forests is critical for modeling both carbon and nitrogen (N) cycles under changing climatic conditions. Hypotheses about the distribution of legumes through secondary succession have rarely been tested explicitly or at a large scale across tropical ecosystems. Our main goal was to explore the distribution of N-fixing and non-fixing legumes across environmental gradients of rainfall and succession in tropical forests.
Methods. We used a previously published database of 36 chronosequence studies in the Neotropics to understand patterns of legume species abundance through secondary forest succession (through collaboration with 2ndFOR, Poorter et al 2016). It includes sites from eight Central and South American countries, and across the network, mean annual precipitation (MAP) varies from 788 to 4000 mm. For each chronosequence, we modeled proportional legume basal area (BA) as a function of time since abandonment and compared initial relative legume BA and the rate of legume BA accumulation (intercept and slope) to MAP.
Results. Our initial results suggest the highest levels of relative legume BA are found in tropical dry forests (MAP < 1500 mm) and that this index decreases with increasing rainfall. The rate at which the proportion of legume BA declined with time was faster in tropical dry forests than in wetter forests. Finally, 20 years after disturbance, legumes are more abundant in dry forests than forests with higher precipitation. The relationships between indices of legume abundance and rainfall were stronger for N-fixing species relative to non-fixing legumes.
Discussion and conclusions. The observed patterns of legume abundance across Neotropical forests suggest a similar trend of high success of these taxa in early successional forests and decline with forest age. However, species from the Fabaceae family are overwhelmingly more abundant in drier forests. Because legumes thrive across a broad range of ecological and climatic conditions, subsequent research will evaluate the relative contribution of phylogenetic, functional and ecological factors on the overall success of this hyperdiverse group of tropical trees.

O2-08 – S2 *Success of tropical legumes and traits that contribute to their dominance*
Monday 20 June 20 / 11:00-15:30 – Einstein

The role of N2-fixating legumes in neotropical dry forests: insights from ecosystem modeling

ANNETTE TRIERWEILER[1], XIANGTAO XU[1], MARIE GEI[2], JENNIFER POWERS[2], DAVID MEDVIGY[1]
[1]Princeton University, Geosciences, 08544, Princeton, United States
[2]University of Minnesota, Ecology, Evolution, and Behavoir, 55108, St Paul, United States

Background: Legumes are abundant and exhibit a wide diversity of N2-fixing strategies in tropical dry forests (TDFs), but their importance is not fully understood. TDFs are interesting because they often face multiple resource constraints (water and nutrients) and have immense functional diversity. The abundance and diversity of N2-fixing legumes may influence whether TDFs will be particularly vulnerable or uniquely adapted to projected global change. Here, we use models to examine the role of TDF legumes and to predict ecosystem response to environmental perturbations.
Methods: We use a new version of the Ecosystem Demography (ED2) model that has been recently parameterized for TDFs. ED2 is one of the few models specifically parameterized for TDFS and multiple resource constraints (carbon, nitrogen, phosphorus, and water). We represent legumes and other functional groups found in TDFs with resource acquisition strategies that range from "conservative" to "acquisitive". In the model, resource acquisition and tissue stoichiometry determines which nutrient is limiting. Plants then can dynamically adjust their investment in leaves, stem and roots as well adopt strategies for nutrient acquisition (e.g. N2-fixing bacteria and mycorrhizal fungi). We test the model's performance against a nutrient gradient of field sites from Costa Rica. We also simulated community responses to nutrient fertilization experiments and to extreme drought conditions may be expected under future climate.
Results: We found that the inclusion of the N2-fixation legume traits were critical to reproducing community dynamics of Costa Rican field TDF sites. Legumes can have a large impact on forest biomass and was necessary to capture realistic TDF forest structure. In nutrient fertilization simulations, the magnitude of the effect depended on the proportion of fixing legumes. Our preliminary drought simulations indicate that if a severe drought induces mortality of nitrogen fixers, ecosystem recovery may be delayed several decades before carbon storage recovers to pre-drought levels.
Discussion: Overall, our results show that legumes play an important role in tropical dry forests and may impact the biome's sensitivity to changes in climate and nutrient regimes. We highlight both the need for modelling studies to account for legume traits in TDFs and the field data needed to better represent this important functional group in ecosystem models.

O3-01 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

Is the high diversity in tropical forests driven by the interactions between plants and their pests?

PHYLLIS COLEY, THOMAS KURSAR
University of Utah, Department of Biology, 84112, Salt Lake City, USA

The ecological and evolutionary interplay between plants and herbivores may play a pivotal role in divergence, coexistence and speciation of both groups. Here we present data on Inga, one of the most speciose and locally diverse tree genera in the New World tropics. Anti-herbivore defenses show little phylogenetic signal suggesting that taxonomic conservatism is not widespread and that the tempo of evolution for defense traits is faster than for non-defense traits. Furthermore, different defensive adaptations (hairs, extrafloral nectaries, secondary chemistry, development, and phenology) are evolving independently. The major mode of divergence among Inga in secondary metabolites is most likely due to changes in gene regulation leading to novel combinations of common compounds. Despite similar habitat preferences, dozens of Inga species coexist at a single site. Neighboring individuals are more divergent in defenses than expected, indicating that novelty may reduce herbivore pressure. Thus high local diversity within Inga may result from niche differentiation in defenses against herbivores.

O3-02 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

Coevolutionary chemical arms races in a world of generalist insect herbivores

PAUL FINE[1], DIEGO SALAZAR[1], JOHN LOKVAM[1], ITALO MESONES[1], JACQUELINE MILAGROS AYARZA ZUÑIGA[2], MAGNO VÁSQUEZ PILCO[3], PERRY DE VALPINE[4]
[1]UC Berkeley, Integrative Biology, 94720, Berkeley, USA
[2]INPA, Entomology, 69011-970, Manaus, Brazil
[3]INPA, Botany, 69011-970, Manaus, Brazil
[4]UC Berkeley, Enivronmental Science, Policy and Management, 94720, Berkeley, USA

Generalist herbivores are important consumers of most plant species, yet evolutionary and ecological theory has focused on the importance of specialist natural enemies. Consequently, studies on the evolution of plant chemical defenses have typically included one plant, a few metabolites, and a small set of handpicked specialist herbivores. However, plant species are bombarded by dozens of different herbivore species from disparate phylogenetic lineages that span a wide range of dietary breadths and have distinctive physiological constraints that interact differently with particular metabolites. How do plant defense chemicals evolve under such multiple and contrasting selective pressures imposed by entire herbivore communities? Here we present the most detailed accounting to date of the insect herbivore fauna and phytochemistry of a tropical tree genus. We censused 860 individual saplings of 32 Protium (Burseraceae) tree species for 64 weeks in the Allpahuayo-Mishana National Reserve near Iquitos Peru and observed ca. 4500 feeding events by 210 insect morphospecies from 13 families and 5 orders. Leaves from 6 individuals of each species were exhaustively characterized for secondary metabolites. Host-specialist herbivores were extremely rare; on average insect herbivores consumed 9 different Protium species. We found ca. 600 different chemicals (average 71 compounds per species). Chemical diversity and investment significantly correlated with herbivore feeding records; Protium species with a higher diversity and abundance of natural products had a lower diversity and abundance of herbivores. We adapted a set of Statistical Learning tools to assess the effect that different metabolites had on each herbivore species. Almost all herbivore species were repelled by at least one plant metabolite, however; no single compound repelled more than 8 herbivore species. Moreover, metabolites with a strong negative effect on herbivore attack were more conserved across the Protium phylogeny and showed a stronger phylogenetic signal than other metabolites. In combination, these results confirm the role that insect herbivores have had on the diversification of Protium's rich chemical arsenal. Furthermore, these findings suggest that plant chemical diversity is likely the cumulative result of a multitude of plant-herbivore interactions rather than the outcome of a chemical defense escalation driven by a small set of specialized herbivores.

O3-03 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

Testing the effect of plant chemical and phylogenetic diversity on herbivore damage and local community assembly

DIEGO SALAZAR[1], ROBERT J. MARQUIS[2]
[1]University of California Berkeley, Integrative Biology department, 94720, Berkeley, USA
[2]University of Missouri-St. Louis, Biology department, 63121, Saint Louis, USA

Ecologists have strived to find mechanisms that govern the assembly of natural communities. Particularly challenging to explain are "species swarms" of understory herbs, shrubs, and trees found in tropical wet forests. Classical ecological theory predicts that in order for coexistence to occur, species differences need to be maximized across biologically important niche dimensions. New evidence suggests that natural enemies and chemical defenses could play an important role in the assembly of hyper-diverse tropical plant communities. It has been recently suggested that, within a particular plant community, species that maximize the difference in chemical defense profiles compared to neighboring taxa will have a relative competitive advantage. Here we experimentally tested the relationship between chemical community diversity, phylogenetic diversity, plant–herbivore interactions, and plant community assembly. We used an array of 60 experimental multi-species Piper (Piperaceae) communities (~1500 individuals from 16 Piperspecies) planted into the native undisturbed, lowland wet forest of the La Selva Biological Station, Sarapiqui, Costa Rica. We purposely manipulated species composition to create significantly different chemical and phylogenetic community compositions for each plot. After one year of exposure to herbivores, plots with high chemical diversity suffered significantly less herbivore damage, lower plant mortality, and less local extinction than low chemical diversity plots. Although chemical diversity had the strongest effect on local mortality and extinction, phylogenetic diversity had the strongest effect on total herbivore damage. Average total herbivory was 17.5% leaf area missing, approximately half of which was produced by specialist herbivores (8.0%) and half by generalist herbivores (9.5%). Chemical diversity was negatively correlated with damage by specialist herbivores and not by generalist herbivores, suggesting that specialist herbivores are the main driving agent influencing local Piper diversity. Our results support the idea that both natural enemies and plant defenses likely play a significant part in the structuring of local communities and the maintenance of rich tropical biota.

O3-04 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

Herbivores on plants: ecological tracking or coevolutionary arms-race?

MARIA-JOSE ENDARA[1], GABRIELLE GHABASH[1], JAMES NICHOLLS[2], KYLE DEXTER[3], GRAHAM STONE[2], TOBY PENNINGTON[4],
PHYLLIS COLEY[1], THOMAS KURSAR[1]
[1]University of Utah, Biology, 84112, Salt Lake City, USA
[2]University of Edinburgh, School of Biological Sciences, EH9 3FL, Edinburgh, UK
[3]University of Edinburgh, School of GeoSciences, EH9 3FF, Edinburgh, UK
[4]Royal Botanic Garden Edinburgh, Tropical Diversity Section, EH6 4NY, Edinburgh, UK

Because plants and their insect enemies are strikingly species-rich groups, understanding their interactions has been a key issue in ecology and evolution. Coevolutionary theory has long predicted that the arms race between plants and insects may drive diversification in both groups and has led to evolutionary conservatism in plant defenses and in host use by insect herbivores. We tested these expectations using the Neotropical genus of trees Inga (Fabaceae) and its associated lepidopteran herbivores in the Peruvian Amazon. We constructed multilocus phylogenies for both plants and insects and collected data on host associations and plant defensive traits. Contrary to the coevolutionary model, our results showed that host defensive traits were not phylogenetically conserved. Similarity in herbivore assemblages between Inga species pairs was correlated with similarity in defensive traits, but not phylogenetic proximity. Furthermore, host defensive traits explained 40% of observed herbivore community similarity. Analysis at finer taxonomic scales showed that different lepidopteran families select hosts based on different anti-herbivore traits, suggesting taxon-specific histories of herbivore-host plant interactions. Finally, we compared the phylogeny of Inga, the defenses of Inga, and the phylogeny for the major lepidopteran families. We found that closely related herbivores fed on Inga species with similar defenses rather than on closely related plants, a pattern more consistent with ecological resource tracking than with the arms race model of coevolution.
Together, these results suggest that defenses evolve rapidly and that traits related to host choice evolve more slowly. Hence, there is an apparent asymmetry in the evolutionary interactions between Inga and its herbivores. Specifically, although divergence in herbivores might not be driven solely by their interactions with plants, herbivores may be an important factor driving the divergence among plant species.

O3-05 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

The role of defense-chemical divergence in maintaining species richness in hyperdiverse tropical tree genera

BRIAN SEDIO[1], JUAN CAMILO ROJAS ECHEVERRI[2], EDWIN LEBRIJA TREJOS[2], JOSEPH WRIGHT[1]
[1]Smithsonian Tropical Research Institute, (STRI), 0843-03092, Balboa, Ancón, Panamá
[2]Instituto de Investigaciones Científicas y Servicios de Alta Tecnología-AIP, Centro de Biodiversidad y Descubrimiento de Drogas, 0843-01103, Ciudad del Saber, Panamá

Consensus appears to be mounting that biotic interactions with specialist pests and pathogens contribute to the diversity of tropical forests by limiting the local recruitment of conspecific individuals. However, a large part of tropical forest diversity is comprised of a handful of hyperdiverse tree genera, and these are likely to share natural enemies. Diversification of defense chemistry in species-rich genera may reconcile these views by permitting close relatives to partition niche space defined by natural enemies.
The vast diversity of plant chemical defenses has traditionally precluded community-level studies of chemical ecology. We take advantage of novel methods for acquiring and assembling mass spectra (MS) into molecular networks in which similarities in MS fragmentation patterns, and hence chemical structure, are indicated by proximity of compounds within the network. Molecular networks permit the quantification of chemical similarities between samples for which few compounds have been unambiguously structurally elucidated, an attractive utility in chemically diverse and understudied tropical forests.
Here, we assemble MS molecular networks for 185 tree species that represent 95% of all individuals in the Smithsonian Institution Global Earth Observatory (ForestGEO-CTFS) Forest Dynamics Plots in Maryland and at Barro Colorado Island (BCI), Panama. We ask i) does seedling recruitment depends on the chemical neighborhood in which the seedling occurs? and ii) does phylogenetic signal in secondary chemistry decline with phylogenetic scale (i.e. is there divergence in chemistry among close relatives within species-rich genera)?
Our models indicate a substantial effect of chemical neighborhood on the recruitment of seedlings in both forests. We find a much stronger chemical neighborhood effect in tropical tree genera, and a breakdown of phylogenetic signal in chemistry in tropical but not temperate tree genera.
Our results suggest that species differences in secondary chemistry may comprise important axes of niche differentiation among coexisting species of tropical trees. Furthermore, chemical differences may be especially important among members of species-rich woody plant genera that otherwise share many aspects of the niche. Finally, the contrast in results between Maryland and Panama hint that the importance of chemically-defined niche differences to species coexistence may vary importantly over latitude.

O3-06 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
Monday 20 June 20 / 16:00-17:30 – Einstein

Trans-Amazonian patterns in the richness and diversity of insect herbivores of neotropical Inga trees

GRAHAM STONE[1], JAMES NICHOLLS[1], MARIA-JOSE ENDARA[2], KYLE DEXTER[3,4], CATHERINE KIDNER[3,5],
TOBY PENNINGTON[3], PHYLLIS COLEY[2,6], THOMAS KURSAR[2,6]
[1]Institute of Evolutionary Biology, University of Edinburgh, Edinburgh, EH9 3JT UK
[2]Department of Biology, The University of Utah, Salt Lake City, UT 84112-0840, USA
[3]Royal Botanic Garden Edinburgh, Edinburgh, EH3 5LR, UK,
[4]School of Geosciences, University of Edinburgh, Edinburgh, EH9 3FE, UK
[5]Institute of Molecular Plant Sciences, University of Edinburgh, Edinburgh, EH9 3BF UK
[6]Smithsonian Tropical Research Institute, Panama

Background: Rainforest trees and their associated insects are two of the most speciose groups on Earth. One key question concerns the spatial scale of tree-herbivore associations. Research to date suggests frequent sharing of widespread species among locations (high alpha diversity), with low numbers of site-specific species (low beta diversity), with significant impacts of tree phylogeny on associated herbivore assemblages. However, work in the most species-rich rainforests is limited by lack of taxonomic resources for the herbivores, many of which are known only as immature stages.
Methods and Results: We used DNA barcoding of herbivores to examine trans-Amazonian patterns in herbivore assemblages associated with 100 neotropical Inga tree species. We ask to what extent Inga herbivores show the high alpha diversity and low beta diversity associated with other rainforest assemblages, and consider other traits likely to influence herbivore community structure.

O4-01 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

DNA barcode for earthworm taxonomy, biodiversity assessment and conservation of Brazilian species

ELODIE DA SILVA[1], SAMUEL WOOSTER JAMES[2], MARCIO GONCALVES DA ROSA[3], GUILHERME SCHÜHLI[1], MARIE LUISE CAROLINA MARIE[4], THIBAUD DECAENS[5], GEORGE GARDNER BROWN[1]
[1]EMBRAPA FLORESTAS, SOIL ECOLOGY, 834111-000, COLOMBO, BRAZIL
[2]University Of Iowa, Biology, 52242, Iowa City, USA
[3]Universidade Do Estado De Santa Catarina, Soil, 88035-001, Lages, Brazil
[4]Universidade Positivo, Environmental Mana, 81280-330, Curitiba, Brazil
[5]Universite De Montpellier, Cefe Umr 5175 Cnrs, 34293, Montpellier, France

Worldwide, soils and their biodiversity are threatened by land use changes and management practices that can have profound effects on soil organisms that perform important soil ecosystem services. Therefore, it is important to adequately assess populations and biodiversity of soil animals such as earthworms, so that they can be used as bioindicators of sustainable management practices and of environmental quality.
However, our ability to perform this task is greatly hindered by a taxonomic impediment, including the small number of specialists in the tropics, the inability to identify most cocoons, incomplete and/or juvenile worms, the existence of many small and difficult-to-identify species and the absence of easily internet-accessible information on tropical earthworm ecology and taxonomy. These limitations are especially problematic in Brazil, home to about 10% of the world's biodiversity and where rapid land-use changes and management practices are threatening a biodiversity that we are not even fully aware of yet, due to the vast number of still undescribed species. The present research work addresses these issues/limitations, focusing on a major soil ecosystem engineer: the earthworms.
The Cytochrome Oxidase 1 (COI) barcode region has been shown to be very effective for earthworms, allowing species-level identification of adults, juveniles and cocoons. While the Barcode sequence itself is not sufficient for robust phylogenetic tree generation, it is a valuable tool for preliminary species delineation, detection of cryptic species, and estimation of biodiversity.
At present, there are barcodes for ~600 earthworms from 175 sites, mainly in Southern Brazil. In total, we estimate that barcodes have been generated for approx. 175 species, most of them new to science, with > 14-15% genetic distances. In S and SE Brazil, approximately 56 species-level lineages of Glossoscolex and Fimoscolex were found, most of which belonged to undescribed species. The neighbor joining tree of these sequences shows geographical structure within each genus, sometimes on very small spatial scales. Barcoding has helped to separate morphologically similar species, species with more complicated taxonomy and show geographic variation within species.
While there are still restrictions to the extensive use of barcodes for identifying of Brazilian species, we still expect that a comprehensive database can be a powerful taxonomic tool that merits further development.

O4-02 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Diversity and structure of tropical earthworm communities as revealed by DNA barcoding

THIBAUD DECAËNS[1], DAVID PORCO[1], SAMUEL W. JAMES[2], ELODIE DA SILVA[3], LISE DUPONT[4], EMMANUEL LAPIED[5], RODOLPHE ROUGERIE[6], VIRGINIE ROY[4]
[1]University of Montpellier, UMR CEFE, 34293, Montpellier, France
[2]University of Iowa, Department of Biology, IA 52242, Iowa City, USA
[3]EMBRAPA, Florestas, 83411, Curitiba, Brazil
[4]University of Créteil, UMR IEES, 94010, Créteil, France
[5]Norwegian University of Life Sciences, NBIO, 1431, As, Norway(6) MNHN, UMR ISYEB, 75005, Paris, France

Despite being recognized as important actors of soil functioning, earthworms have been poorly considered from a taxonomic perspective. As a consequence, the nearly 6000 species currently recognized worldwide probably represent at best half the actual biodiversity of the group. This taxonomic deficit is particularly critical in the tropics, resulting in difficult species identifications and a lack of ecological studies on earthworm communities.
Earthworm communities were sampled in eight study sites of French Guiana (grants from CNRS-Nouagues and Labex CEBA). In each site, a rapid screening of communities was achieved in a selection of habitats using a standardized protocol based on the systematic harvesting of specimens in all types of microhabitats available in a 1 ha area. DNA barcodes (COI gene) obtained for a selection of specimens were used to delimit molecular operational taxonomic units (MOTUs), the number and composition of which was further used to describe community diversity and structure at different spatial scales.
DNA barcodes produced for 2826 specimens clustered into 166 MOTUs, resulting in a great improvement of our knowledge of regional diversity, as compared to the 22 species that were reported for French Guiana in a recent checklist. Beta-diversity among sites was high, with up to 70% of the MOTUs only found in a single study site. As a consequence, the number of species accumulates steadily with the number of study sites sampled, and a rough estimates suggests that at least 400 species could be found in French Guiana. This region of Amazonian forests could therefore represent one of the richest hotspots for earthworm diversity, and additional research is critically needed to progress toward documenting the actual number of species in this region.
At a local scale, assemblages seem to be dominated by specialist species, with only a small fraction of generalists able to colonize a broad range of habitats or microhabitats. The number of species co-existing in a given habitat never exceeded 15 MOTUs, suggesting that interspecific competition may drive niche saturation during the process of community assembly. The ongoing development of a functional trait database will allow combining functional, phylogenetic and taxonomic diversity approaches in order to disentangle the relative contribution of habitat filters, biotic interactions and neutral processes in the structuring of earthworm communities in the rainforest of French Guiana.

O4-03 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Multi-scale spatial analysis of tropical earthworm assemblages – Biotic interactions and environmental drivers

JUAN JOSÉ JIMÉNEZ[1], THIBAUD DECAËNS[2], PATRICK LAVELLE[3], JEAN-PIERRE ROSSI[4]
[1]IPE-CSIC, Biodiversity Conservation and Ecological Restoration, 22700, Jaca, Spain
[2]CEFE-CNRS, Ecologie Fonctionnelle et Evolutive, 34293, Montpellier, France
[3]IRD, Écologie des Sols Tropicaux, 93143, Bondy, France
[4]INRA, UMR CBGP, 34988, Montferrier-sur-Lez, France

Ecological processes are spatially influenced on various scales, ranging from global to local scales. In natural communities, the observed spatial pattern is the result of environmental, biological and/or historical drivers, which are not exclusive but rather complementary. Disentangling the spatial scales at which species assemblages are structured, and if these match those expressed by soil environment is of paramount importance in soil ecology. Soil invertebrates are spatially distributed at different scales, with stable patches of high- and low population density. Null-model analysis and niche overlap indices in combination with spatially explicit multivariate analysis shed light about the drivers explaining spatial distribution of soil organisms. In some communities competing species can coexist in the same patch where soil resources are more patchily distributed. The effect of soil environmental heterogeneity on litter-feeding species was not only highlighted, but also the impact of endogeic species onto soil physical properties. With the use of spatially explicit multivariate analysis and variation partitioning analysis, the spatial organization of earthworm assemblages and soil environmental parameters revealed explicitly multi-scale responses. However, for some species, a large proportion of the spatial variation was not dependent on soil environmental variability. How much spatial planning is operated in soils by soil ecosystem engineers and to what extent this process determines ecosystem function and processes needs further assessment.

O4-04 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Earthworms and spatially self-organized landscapes in seasonal tropical wetlands

DOYLE MCKEY[1], DELPHINE RENARD[2], ANNE ZANGERLÉ[3], RUMSAÏS BLATRIX[1], KISAY ADAME MONTOYA[4], ELENA SUAREZ JIMENEZ[4]
[1]Université de Montpellier, CEFE, F-34293, Montpellier, France
[2]University of California, Santa Barbara, Bren School of Environmental Science and Management, 93106-5131, Santa Barbara, CA, USA
[3]Technische Universität Braunschweig, Institut für Geoökologie, D-38106, Braunschweig, Germany
[4]Undacion Universitaria Internacional del Tropico Americano, Unitropico, Cra. 19, Yopal, Colombia

Background: In the semi-arid tropics, patterned landscapes (e.g., spotted bush, striped bush) built by feedbacks between organisms and the abiotic environment are well-known. Similar patterned landscapes occur in seasonal tropical wetlands, but are poorly known. Some are reported to be built by earthworms. The surales, regularly spaced mounds up to 2 m high and 5 m broad, occupy large areas of seasonally shallowly flooded savanna in the Orinoco Llanos. The ecology of these landscapes is virtually unknown. We asked the following questions. (1) What is the geographical extent of surales landscapes? (2) How were they formed? (3) What explains variation among sites in the size and shape of mounds? (4) How does the topographic heterogeneity of surales landscapes affect biotic communities?
Methods: In surales sites featuring a range of sizes and shapes of mounds, we combined remote sensing techniques (satellite imagery and aerial photography using a drone) with field studies of the effects of soil macrofauna, principally earthworms, on bioturbation and on soil structure. We analyzed plant microfossils in soils to gain insight into vegetation history, and surveyed biodiversity of plants and of soil macrofauna within and among sites.
Results: Mounds are largely comprised of casts of a single large earthworm species. Variation among sites in size of mounds reflects a chronosequence of surales growth. Mounds are initiated when the earthworm feeds in shallowly flooded soils, depositing casts above water level to form a small tower. Using permanent galleries, each earthworm returns repeatedly to the same spot to deposit casts and to respire. Over time, the tower becomes a mound. As each earthworm has a restricted foraging radius, there is net movement of soil to the mound from the surrounding area. As the mound grows, its basin thus becomes deeper, making initiation of a new mound nearby more difficult, driving the regular spacing of mounds. When mounds already initiated are close together, the basin between them fills and mounds coalesce to form larger composite mounds.
Discussion: One large earthworm species drives self-organizing processes that produce keystone structures determining ecosystem functioning and development. These processes are analogous to those that produced patterned landscapes in semi-arid regions. Comparative study of similar patterned landscapes built by earthworms in seasonal wetlands elsewhere in the tropics would be enlightening.

O4-05 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Phylogenetic assessment within a complex of tropical peregrine species, Pontoscolex corethrurus

SHABNAM TAHERI[1], SAMUEL W. JAMES[2], THIBAUD DECAËNS[3], VIRGINIE ROY[1], RODOLPHE ROUGERIE[4], BRONWYN WILLIAMS[5], FRANK ANDERSON[5], GEORGE G. BROWN[6], LUIS CUNHA[6], ELODIE DA SILVA[6], CHIH-HAN CHANG[7], LISE DUPONT[1]
[1]University Paris-Est Créteil, iEES-Paris, 94010, Créteil, France
[2]University of Iowa, Department of Biology, 52242-1324, Iowa, USA
[3]University of Montpellier, Ecologie Fonctionnelle et Evolutive, 34293, Montpellier, France
[4]Muséum National d'Histoire Naturelle, Systématique, Evolution, Biodiversité, 75005, Paris, France
[5]Southern Illinois University, Department of Zoology, 62901, Carbondale, USA
[6]Embrapa Florestas, Ecologia do Solo, 83411-000, Colombo, Brazil
[7]Johns Hopkins University Baltimore, Department of Earth and Planetary Sciences, 21218, Maryland, USA

Background: Earthworms are among the most important soil animals in terms of biomass and activity. However, despite their importance, they suffer from a strong taxonomic deficit. It exists more tropical than temperate earthworm species, but it is interesting that the proportion of peregrines is much higher among temperate species (Hendrix et al., 2008). Moreover, recent use of molecular approaches has shown that already described species comprise several different genetic lineages, which may represent cryptic species. These cryptic lineages could differ in their biological and ecological features. One of the most distributed earthworm species in tropical region is Pontoscolex corethrurus. Although this species is one of the most studied earthworm species in soil science, little is known about its genetics except that a cryptic lineage has been found on Azores Island (Cunha et al., 2014). The aims of this study were (i) to describe the genetic variation within P.corethrurus, (ii) to investigate the relationship between different genetic lineages, and (iii) to characterize morphological differences among these lineages.
Method: Samples were collected by soil macrofauna specialists from all over the world and were analyzed using mitochondrial (16s and COI) and nuclear (ITS2 and 28s) molecular markers. Phylogenetic trees were produced by Bayesian and maximum likelihood methods. From each divergent lineage at least 2 individuals were morphologically analyzed, looking at (i) the regularity, shape and arrangement of the setae on tail, (ii) the number of clitellum segments and the tubercula pubertatis position and (iii) the presence or absence of seminal vesicles.
Results: Genetic divergence between lineages and observed morphological differences, showed that this dataset gather 9 divergent lineages. Among them, 5 lineages present morphological differences and are likely different species while no morphological difference was observed for the 4 other lineages which could represent cryptic species.
Discussion/Conclusion: Based on these results, it is possible that till now, other species have been mistaken for P.corethrurus, and we highlight the necessity to check the taxonomic status of Pontoscolex sp. specimens using molecular markers before including them in a scientific study. In the future, a meta-analysis of the literature could emphasize the possibility that different species or cryptic lineages have been erroneously identified as Pontoscolex corethrurus.

O4-06 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Origin and dynamic of cathedral and lenticular mounds in Southern Indian forests

PASCAL JOUQUET[1], EKTA CHAUDHARY[3]
[1]Institute of Research for Development (IRD), Institute of Ecology and Environmental Sciences (UMR 242 iEES Paris), 93143, Bondy, France
[2]Indian Institute of Science (IISc), Indo-French Cell for Water Science (IFCWS), Civil engineering Department, 560012, Bangalore, India
[3]Indian Institute of Science (IISc), Centre for Ecological Sciences (CES), 560012, Bangalore, India

Termite mounds are not only conspicuous features of African landscapes. In southern India, two types of above-ground termite mounds are commonly observed in forests. The first category corresponds to cathedral mounds (Ob) and the second to lenticular mounds (DOM). If Ob mounds are built by the fungus-growing termite species Odontotermes obesus, the origin and evolution of DOM mounds remains unknown. This presentation investigates the functional impact, origin and dynamic of these two types of termite mounds in two different soil environment (vertisol vs. ferralsol). Ob and DOM mound densities reach approximately 3.5 and 13 mounds ha-1, respectively, which corresponds to an average volume of soil of about 40 m3 ha-1. Using soil physical, chemical and mineralogical properties, we show that the two types of termite mounds are made of soil collected at approximately 20 and 30 cm deep and we highlight gradient in soil properties from Ob to DOM, suggesting three possible scenarios: (1) a progressive erosion of Ob that leads to the recovery of soil properties similar than those observed in the surrounding environment (CTRL); (2) utilization of Ob mounds by other termite species, thus forming DOM mounds, which acquire very different soil properties than CTRL in increasing in size; and/or (3) the formation of DOM mounds from CTRL, independently from Ob. In conclusion, the soil type (ferralsol vs. vertisol) has no influence on the origin and dynamic of Ob and DOM mounds. This study also highlights that the fate of Ob and DOM mounds can be complex, and that more data and especially long term databases are needed for determining the origin and evolution of termite mounds.

O4-07 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

Should we fear termites?

DOMINIQUE LOUPPE
Cirad, Es - UPR BSEF, 34398, Montpellier, France

This presentation is the introduction to the session, which will discuss the relationship between termites, soils and tree diversity in tropical forests.
Termites are insects known to attack dead wood, especially in buildings, and also crops and newly planted trees, giving termites a bad reputation and making them feared by all.
However, without termites the understorey of tropical forests would be covered with heaps of dead wood. So termites are definitely useful. In addition, termites also provide other services to humans, for food, poultry, agriculture, etc., and to the environment itself.
Termites have a major impact on soil quality, particularly on soil richness by increasing the pH, and the carbon and moisture content. Large termite mounds are much sought after by farmers in the Kisangani region (DRC) as they provide evidence of high soil fertility. In addition, termite burrows increase the infiltration of runoff waters and the galleries improve soil aeration; termites cultivate fungi on organic matter, increasing soil carbon content, etc. Some termite mounds may be indicators of soil quality: for example, typical termite mounds are found in temporarily flooded areas. All this explains why many tree species are associated with termite mounds where they exhibit better growth.
Termite diversity is very high, with about 4000 species (only 2600 known) and their distribution throughout the world shows how important it is to focus on termite impacts on the environment and forest diversity.

O4-08 – S4 *Termites, earthworms and tropical soils: their diversity and conservation*
Monday 20 June 20 / 11:00-15:30 – Sully1

What do humus-feeding soldierless termites really feed on?

YVES ROISIN[1], THOMAS BOURGUIGNON[2], JOHANNA ROMERO ARIAS[1]
[1]Université Libre de Bruxelles, Evolutionary Biology & Ecology, B-1050, Brussels, Belgium
[2]University of Sydney, School of Biological Sciences, NSW 2006, Sydney, Australia

Background - Basal termites feed on wood, which they digest with the help of symbiotic protists. The most diverse and abundant termite family in the tropics, the Termitidae, have lost the protists. They rely either on a domesticated fungus (Macrotermitinae) or on a broad diversity of bacterial digestive symbionts (other subfamilies). Species of this latter group feed on a variety of substrates: some eat sound wood, while others (e.g., the Cubitermes-group) exploit clay-bound peptidic residues linked to humic acids. Between these extremes, there is however a broad range of alimentary niches occupied by many species variously qualified as [soil-wood] interface, intermediate, humus, or group III feeders (group II being wood feeders and group IV deep soil feeders), a variety of terms concealing our ignorance about their real source of alimentation. Here, I present some preliminary data on the diet of soldierless Apicotermitinae, a diverse and ecologically dominant group in African and American tropics, comprising many intermediate feeders.
Methods - We follow a multidisciplinary approach, including data on mandible morhology, digestive tract anatomy, gut content, stable isotope studies and analyses of foraging substrate.
Results - Soldierless termites present a remarkable diversity in their digestive anatomy, including crop size, gizzard and enteric valve armature, mixed segment and hind gut configuration. In French Guiana rainforests, soldierless termites forage on various substrates, including highly decayed wood, nest material from other termites, or soil, associated or not with trees or palms. Stable nitrogen isotope ratios differentiate species along the gradient of humification. They cover a very broad range of values and correlate with substrate properties. However, there is no simple relationship between gut anatomy and level of food source humification.
Discussion - Niche differentiation along the gradient of humification explains for a part the huge species richness of Neotropical soldierless termites. However, a finer analysis of actual food sources is needed to test for niche differentiation according to other criteria, and the diversity in gut anatomy remains to be explained. Besides analysing gut contents in more detail, we are now carrying parallel studies on African taxa and plotting results against a phylogenetic background to enlighten character evolution.

O5-01 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

The Andes-Amazonian system and the effects of Neogene landscape changes on plant composition

HOORN CARINA[1], SONIA SALAMANCA[2], ELS E. VAN SOELEN3, MILAN L. TEUNISSEN-VAN MANEN[4], SUZETTE G.A. FLANTUA[4], ROBERTO VENTURA SANTOS[5], MARTIN RODDAZ[6], ELTON LUIZ DANTAS[6], EMIEL VAN LOON[7], JAAP S. SINNINGHE DAMSTE[8], JUNG-HYUN KIM[9]
[1]Paleoecology and Landscape Ecology (P&L) Institute for Biodiversity and Ecosystem Dynamics (IBED) University of Amsterdam P.O. Box 94248, 1090 GE Amsterdam, The Netherlands
[2]Villegas, Biostatistics, Ida Gerhardlaan 9, 2104 SH Heemstede, The Netherlands
[3]Department of Marine Microbiology and Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, and Utrecht University, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands
[4]Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, PO Box 94248, 1090 GE Amsterdam, The Netherlands
[5]Instituto de Geoci^encias, Universidade de Bras ılia, CEP 70910-900 Bras ılia, DF, Brazil
[6]Geosciences-Environnement Toulouse, Universit e de Toulouse, UPS (SVTOMP), CNRS, IRD, 14 Avenue Edouard Belin, F-31400 Toulouse, France
[7]Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, PO Box 94248, 1090 GE Amsterdam, The Netherlands
[8]Department of Marine Microbiology and Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, and Utrecht University, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands
[9]Department of Marine Microbiology and Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, presently at Department of Marine Science and Convergence Technology, Hanyang University ERICA campus, 55 Hanyangdaehakro, Sangnok-gu, Ansan-si, Gyeonggi-do 426-791, South Korea

The Andes and Amazonian histories are intimately related, which is evident from Neogene (c. 23-2.5 Ma) geological records extending from the Andean foothills to the Atlantic margin in eastern Brazil. But how this interaction influenced plant evolution and biogeography is not yet well understood. Here I will discuss how the combination of geological and palynological data can help us to better understand plant history in this region. Palynological records in Colombia, Brazil and Venezuela, indicate that common modern rain forest taxa already existed in the Neogene. Other (extinct) taxa, however, point at distinctly different plant assemblages. What do they represent and why did they go extinct? The combined geological and palynological records may provide some answers. New data from Colombian Amazonia suggest that around c.16-17 Ma, sediments from the now Orinoco drainage basin flowed into western Amazonia with an additional sediment source in the emerging Eastern Cordillera. Both, a low Andes and the Middle Miocene Climatic Optimum (17-15 Ma) might have been responsible for a dryer regional climate that was paired with characteristic (drought-resilient?) plant assemblages. At a later stage (c. 15-9 Ma) Andean sediment input into the Amazon drainage basin prevailed and palm and fern taxa dominated in the extensive aquatic environment of the so-called Pebas system. Marine influence was important throughout the Miocene with coastal taxa occurring in the Amazonian heartland. Modern biodiversity is associated with the Andes-derived substrates in western Amazonia, which coincide with the former Pebas system. It remains to be resolved if –and which proportion of– the modern forest is a relict of the Neogene landscape processes in the Andes-Amazonian system.

O5-02 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

Pleistocene evolution of floristic assemblages in the northern Andes

HENRY HOOGHIEMSTRA[1], VLADIMIR TORRES[2], MIRELLA GROOT[1], GIOVANNI BOGOTÁ-ANGEL[3], LUCAS LOURENS[4], JOHN VAN BOXEL[1], ZAIRE GONZÁLEZ-CARRANZA[1], SUZETTE FLANTUA[1], JUAN-CARLOS BERRIO[5], VIVIAN FELDE[6], JOHN BIRKS[6]
[1]Univ. of Amsterdam, Paleoecology, 1098XH, Amsterdam, The Netherlands
[2]Exxon Mobil, Houston, USA
[3]Univ. Distrital, Bogotá, Colombia
[4]Univ. of Utrecht, Geosciences, Utrecht, The Netherlands
[5]Univ. of Leicester, Dept. of Geography, Leicester, UK
[6]Univ. of Bergen, Dept. of Botany, Bergen, Norway

Background: High-resolution and deep-time pollen records show with unprecedented accuracy changes in floral assemblages. Determinants of changing plant assembly are (1) extrinsic environmental control (physiological and demographic responses of species to the environment), (2) intrinsic interactions (predation, parasitism, herbivory, competition), and (3) neutral theory: ecosystems are structured by stochastic processes (dispersal, recruitement, mortality, historical legacies).
Method: Pleistocene climate change caused altitudinal shifts of main montane plant associations. The topography of the mountains determine breaks in connectivity leading to repeated fragmentation and fusion of plant distribution areas. Dynamic floristic assemblages are overruled by immigration events changing instantaneously, or slowly, the competitional balance between species.
Result: Here we focus on changing Pleistocene plant assemblages in the 2,250,000-yr long Funza09 pollen record (2100 time slices), the 284,000-yr ka long Fuquene9C pollen record (4500 time slices), and the 14,000-yr long LaCocha pollen record (550 time slices). At a Pleistocene time sacale cyclic changes occured at a ~2700-yr rhythm, and similar floristic and environmental conditions occurred maximally some 800-yr. Rates of altitudinal migration, reflecting temperature change, vary from 2° to 3°C/100-yr during glacial conditions (occurring during >60% of Pleistocene time), up to 10°C/100-yr at glacial-interglacial transitions.
Conclusion: Numerical data analysis is required to explore in large data sets dynamics in plant assembly. High resolution-well dated data sets of past ecosystem dynamics may contribute to a better understanding of ecological questions from today. Bringing paleoecology and ecology closer together is a challenge with benefits for both disciplines.

O5-03 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

Holocene Variability of an Amazonian Hyperdominant

CRYSTAL MCMICHAEL[1], MARK BUSH[2]
[1]University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics, 1098XH, Amsterdam, Netherlands
[2]Florida Institute of Technology, Biological Sciences, 32901, Melbourne, United States

Background: The long-term stability of Amazonian communities is unknown. The most abundant species, hyperdominants, may have risen to prominence at the Pleistocene-Holocene transition, following subsequent changes in moisture, or as a result of human activity later in the Holocene. Here, we examined the spatio-temporal patterns of one of the most common Amazonian hyperdominant taxa, Iriartea deltoidea.
Methods:
The fossil pollen history of the commonest western Amazonian tree, Iriartea deltoidea, is investigated using fossil pollen data from 13 lakes. Iriartea is a monospecific genus with diagnostic pollen. It is also considered a 'useful' plant, and its abundance could have been enriched by human action.
Results:
Iriartea pollen was found to have increased in abundance in the last 3000 years, but did not show a consistent relationship with human activity. The abundance of Iriartea pollen is related to increasing precipitation, not human activity over the last 3000 years. This member of the hyperdominant category of Amazonian trees has only recently acquired this status.
Discussion:
The suggestion that the hyperdominants in modern Amazonian forests are a legacy of pre-Columbian people is unsupported. This finding is consistent with the suggestion that communities in complex systems are ephemeral and that the even the most abundant of hyperdominants can change over a few tens of generations. The relative abundance of tree species, even in relatively stable systems such as those of Amazonian floodplains, changes on ecological not evolutionary timescales.

O5-04 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

Evidence of drought phases in the Guinean periforest savanna since the African Humid Period

LAURENT BREMOND[1], CHARLY FAVIER[1], JULIE C. ALEMAN[2], BENOIT BROSSIER[1], RICHARD OSLISLY[3], SANDRINE CANAL[1], OLGA YONGO[4], ILHAM BENTALEB[1], BONAVENTURE SONKÉ[5], MARIE-PIERRE LEDRU[1], CHRISTELLE WONKAM[1]
[1]Institut des Sciences de l'Evolution, UM, CNRS, IRD, EPHE, Montpellier, France
[2]Ecology and Evolutionary Biology, Yale University, USA
[3]Institut de Recherche pour le Développement (IRD), Gabon
[4]Université de Bangui, Central African Republic
[5]Plant Systematic and Ecology Laboratory, University of Yaounde I, Cameroon

Guinean periforest savannas are characterized by a climate humid enough to sustain forest but are maintained by recurrent fires, making them highly sensitive to climatic changes. The termination of the African Humid Period, around 2800 BP, induced the formation of these periforest savannas from formerly afforested areas. Later on, evidences that Tropical Africa experienced shorter-term climatic changes, with alternating wetter and drier periods were recorded both in West and East Africa. Until now, no studies have envisaged how these climatic changes affected the savannas located North of the forest domain. We thus investigated fossil pollen assemblages in a 2900-year-long sediment record from a lake in Southwestern Central African Republic. We traced the evolution of the swamp forest surrounding the lake, which provided a proxy for lake levels and thus for local climatic water regime, and analyzed the long-term ecosystem responses to the Late Holocene climatic changes. The filling of the lake took place around 2900 BP when more humid conditions occurred after a probable erosion phase concomitant to the destruction of the forest cover. After that, a drying trend from 2700 BP to 1000 BP was observed, followed by a wetting trend since then. Shorter period of climatic fluctuations were superimposed to this long-term trend, inducing shifts between savanna alternative stable states. However, the northern limits of the tropical humid forest, presently located only 50km southward, never reached the surroundings of the studied lake since AHP termination.

O5-05 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

Assessing human impacts on the vegetation of the biodiverse eastern Andean flank before, and after, the arrival of Europeans (AD 1492)

NICHOLAS LOUGHLIN[2], ENACRNI MONTOYA[3], ANGELA COE2, WILLIAM GOSLING[1]
[1]University of Amsterdam, Institute for Biodiversity & Ecosystem Dynamics, 1098 XE, Amsterdam, Netherlands
[2]The Open University, Department of Environment, Earth & Ecosystems, MK7 6AA, Milton Keynes, United Kingdom
[3]CSIC, Institute of Earth Science Jaume Almera, E-08028, Barcelona, Spain

The tropical Andean region has been identified as a biodiversity hotspot that is vulnerable to degradation by growing human populations. However, little is known about the extent to which people modified these ecosystems in the past. An improved understanding of past human impacts on the biodiverse ecosystems of the Andes could provide useful insights for conservation into the likely consequences of the increasing pressure from modern human populations. Information on past human impacts can be obtained through examination of biotic and abiotic indicators contained within lake sediment that have accumulated over thousands of years. In this paper we present new data from the eastern Andean flank (Ecuador) that sheds new light on the impact of human populations, pre- and post-European arrival (AD 1492), on the biodiverse cloud forest.
In November 2013 sedimentary cores were recovered from Lake Huila, Ecuador (0° 25' 24.30» S, 78° 1' 4.50» W; c. 2600 m above sea level) using a cam-modified Livingstone piston corer. Lake Huila is situated on an exposed plateau and is today surrounded by open grazed vegetation. Radiocarbon dating of the Lake Huila sediments has revealed the sediments to have accumulated over the last c. 2000 years. Examination of fossil pollen, charcoal, and non-pollen palynomorphs contained within the Lake Huila sediment has provided a record of past vegetation, fire, and animals.
Examination of the fossil record has allowed three distinct ecosystems to be characterised at Lake Huila during the last c. 2000 years. The earliest ecosystem represents a pre-European open landscape characterised by Poaceae, Cyperaceae, Asteraceae, and Chenopodiaceae. Evidence of human occupation in the form of local burning (macro-charcoal), cultivation (Zea mays) and direct human presence (pottery sherds) suggest a significant human impact on the landscape. The second ecosystem is dominated by cloud forest taxa (including Moraceae, Melastomataceae, Hedyosmum, Fabaceae, Weinmannia and Acalypha), with indicators of human influence absent (i.e. no charcoal or cultivars). The most recent ecosystem contains an assemblage dominated by Poaceae, Cyperaceae and Asteraceae with strong evidence for burning (macro-charcoal) and herding (i.e. coprophilous fungal spores); this suggests deforestation and the subsequent establishment of the modern open cattle grazed landscape.

O5-06 – S5 *Changes in floristic assemblages through time: a view on short- and long-term (last decades to million years) dynamics*
Monday 20 June 20 / 16:00-17:30 – Sully1

Determining which are the main biomes of lowland tropical South America and how they differ by using a massive dataset of tree species community surveys

PEDRO LUIZ SILVA DE MIRANDA[1], DANILO M. NEVES[2], TOBY PENNINGTON[3], ARY OLIVEIRA-FILHO[4], KYLE G. DEXTER[1]
[1]University of Edinburgh, School of Geosciences, EH9 3FF, Edinburgh, UK
[2]Royal Botanic Gardens, Kew, Identification and Naming, TW9 3AB, Richmond, UK
[3]Royal Botanic Garden Edinburgh, Tropical Diversity, EH3 5LR, Edinburgh, UK
[4]Universidade Federal de Minas Gerais, Botany, 31270-901, Belo Horizonte, Brazil

Background: Lowland tropical South America (LTSA) is known for the richness and spatial heterogeneity of its flora. As a way of delimitating and understanding patterns of plant species distribution in this region, researchers have used remote sensing images, climatic data and expert opinion to categorize major vegetation types or biomes. A common assumption of biome delimitation is that biomes are floristically coherent – plant communities in a given biome share more species with each other than with plant communities in another biome. However, none of the previous large-scale attempts to classify plant communities of LTSA relied on information about species composition.
Our aim with this study is to determine the primary floristic units of LTSA floristic database comprised of tree species inventories for ~2000 sites.
Methods: The inventories used were recovered from the NeoTropTree dataset (http://prof.icb.ufmg.br/treeatlan/).
We first performed a cluster analyses to determine the main floristic units or biomes. We then interfaced this classification scheme with commonly used climatic variables to see how well these variables can discriminate the biomes. Finally, we estimated how many species are shared amongst biomes, and how many are exclusive to each biome.
Results: Our analysis revealed five main floristic groups: Amazon Forest, Atlantic Forest, Cerrado, Chaco and Seasonally Dry Tropical Forests (SDTFs). These results give quantitative support to many previous qualitative biome delineations. Novel insights include: 1) The forest islands of the Pampa region are not floristically distinct from the Atlantic Forest; 2) Gallery forests within Cerrado cluster with either the Atlantic or Amazonian Forests, depending on their location; 3) Similarly, restinga vegetation clusters with either the Atlantic or Amazonian Forests, depending on their location; and 4) SDTFs from Bolivia to northeast Brazil form a single group, which is geographically interspersed with the Cerrado. In addition, our results convincingly demonstrate that climatic variables cannot be used to delimitate the main biomes of LTSA, especially the dry ones.
Discussion: Our analyses provide a quantitative floristic basis for many previously recognised biomes in LTSA. For example, we found evidence that most SDTF's should be treated as a single biome. It is also noticeable that the Amazon and Atlantic Forests form clearly distinct groups, even though they share a significant number of tree species.

O6-01 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Quantifying the role of lianas in tropical forests: results from liana removal experiments in the Republic of Panama

SCHNITZER STEFAN
Marquette University, Biology, 53201, Milwaukee, United States

Lianas are reputed to have numerous effects on tropical forests, such as reducing tree growth, survival, and reproduction. In turn, these effects may alter community-level diversity and forest-level carbon dynamics. Lianas may also provide resources that structure animal communities. We tested a variety of hypotheses on the effects of lianas in tropical forest ecosystems using a series of recent large-scale liana-removal studies in the Republic of Panama. In these studies, we found that lianas significantly reduced light and soil moisture, which led to substantially lower tree physiological performance, growth, survival, reproduction, recruitment, and regeneration. At the ecosystem level, lianas reduced carbon uptake and storage and, since lianas were unable to compensate for the carbon that they displaced in trees, they lowered the capacity of the forest to uptake and store carbon. Removing lianas also altered the animal community, thus indicating that lianas may structure animal communities. While liana removal studies have led to important discoveries, they also introduce experimental artifacts that need to be considered when interpreting the data, which we discuss.

O6-02 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Are dry seasons helping lianas?

CHRISTINA SMITH[1], CAROLINA BASTOS[2], OMAR LOPEZ[3], JENNIFER POWERS[4], STEFAN SCHNITZER[5]
[1]University of Minnesota, Plant Biology, 55108, Saint Paul, United States
[2]Sao Paulo University, Botany, 05508, Sao Paulo, Brazil
[3]Institute for Advanced Research and Technology, Center for Biodiversity and Drug Discovery, 080814, Clayton, Panama
[4]University of Minnesota, Ecology, Evolution and Behavior, 55108, Saint Paul, United States
[5]Marquette University, Biology, 53201, Milwaukee, United States

Background: Recent studies have shown that the relative abundance of lianas in Neotropical forests is increasing, with profound implications for the global carbon cycle. Therefore, ecologists are interested in understanding factors that influence the relative abundance of tropical lianas and trees. One potential explanation for the increase in lianas is that lianas perform better during seasonal droughts, which are becoming more severe and may be giving lianas a growth advantage over trees. To determine if lianas perform better than trees during seasonal drought, we conducted a study in a four-year old common garden in Central Panama.
Method: In 2011, we planted replicate seedlings of six liana and six tree species in 12 fully exposed garden plots. We added water to 6 of the plots during the dry season each year, while the other six plots received annual rainfall only. In 2015, we randomly chose two individual of each species from each plot and measured predawn and midday leaf water potential (LWP) five times throughout 2015, two times during the dry season, once during the transition from dry to wet season and twice during the wet season. We harvested aboveground biomass of a subsample of individuals from both watering treatments.
Result: Lianas and trees had similar LWP values during the wet season. During the dry season, however, the lianas in the unwatered plots had less negative predawn LWP compared to trees in the unwatered plots, and the watered lianas had less negative values than the watered trees. Lianas in the unwatered plots had on average a greater range of change from predawn to midday LWP than trees in the unwatered plots during the dry season, indicating that lianas were transpiring more than the trees and presumably had higher photosynthetic rates. Aboveground biomass for lianas did not differ between watering treatments, but the watered trees had more biomass than the unwatered trees.
Discussion:Lianas were less stressed by the dry season than trees when they were not watered. Also, the unwatered lianas had higher transpiration rates indicating that not only were they less stress by drought, but they were potentially able to maintain higher levels of photosynthesis. The aboveground biomass data also indicate that lianas were less affected by the dry season than trees. In conclusion, our results suggest that the increasing relative abundance of lianas in Neotropical forests may be driven at least partially by increasing dry season length.

O6-03 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Effects of continued N and P addition on Ecuadorian Andean forests

JÜRGEN HOMEIER[1], NOHEMY POMA[2], JANN AHLERS[1], KATHARINA GIRAY[1]
[1]University of Goettingen, Plant Ecology, 37073, Goettingen, Germany
[2]Universidad Nacional de Loja, Recursos Naturales, Loja, Ecuador

Background: Elevated N and P inputs affect virtually all components and processes of terrestrial ecosystems since the productivity of plant communities is limited by N or P, or both in the vast majority of ecosystems on the globe. Human activities will globally affect the cycles of N and P during the coming decades and tropical forests are likely to respond sensitively to these changes. But the size and direction of these responses are still unclear.
Methods: The effects of continued nutrient addition on tropical montane forest ecosystems are investigated in the Andes of Ecuador (at three elvation levels: 1000m, 2000m and 3000m) within the ongoing interdisciplinary Ecuadorian NUtrient Manipulation EXperiment (NUMEX), that started in January 2008. In this experiment moderate amounts of N (50kg ha-1 yr-1), or P (10kg ha-1 yr-1), or N and P are added to representative old-growth forest stands. We are monitoring the nutrient status of different ecosystem components, nutrient fluxes, and productivity of the experimental plots.
Results: This presentation gives an overview of all observed effects during the study period of 8 years (e.g., significant changes in soil nutrient status and nutrient availability after fertilization, effects on mycorrhizal composition and diversity), but it will focus on variation in fine litter production, litter quality and tree foliar properties.
Discussion: The results of this long-term experiment show, that forest responses to nutrient addition depend on elevation and climate, and also that increasing nutrient deposition is already affecting tropical Andean forests. Although at the stand level not all variables showed significant reactions to nutrient addition, the diverging reactions of tree species suggest that compositional and structural shifts in future forests could be expected.

O6-04 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Amazon forest ecosystem responses to elevated atmospheric CO2: filling the gaps with model-experiment integration

FLORIAN HOFHANSL[1], KATRIN FLEISCHER[2], LUCIA FUCHSLUEGER[1], ANJA RAMMIG[3], KARST SCHAAP[1], OSCAR VALVERDE-BARRANTES[1], DAVID LAPOLA[2]
[1]Instituto Nacional de Pesquisas da Amazônia, Coordenação de Dinâmica Ambiental, BR-69067375, Manaus, Brazil
[2]Universidade Estadual Paulista, Departamento de Ecologia, Laboratório de Ciência do Sistema Terrestre, BR-13506900, Rio Claro, Brazil
[3]Technical University Munich, Land Surface-Atmosphere Interactions, D-85354, Freising, Germany

The impacts of elevated atmospheric CO2 (eCO2) on the carbon storage capacity and resilience of the Amazon forest remain highly uncertain. Carbon dynamics are controlled by multiple eco-physiological processes responding to environmental changes, but we lack solid experimental evidence, hampering theory development and thus representation in ecosystem models.
Here, we present the first free-air carbon enrichment (FACE) experiment to be conducted in Amazonian old-growth forest, that will examine tropical ecosystem responses to eCO2 and thus will elucidate the representation of crucial ecological processes by ecosystem models.
We highlight current gaps in our understanding of tropical ecosystem responses to projected global changes in light of the eco-physiological assumptions considered by current ecosystem models.
We conclude that a more detailed process-based representation of the spatial (e.g., soil type; plant functional type) and temporal (seasonal and inter-annual) variability of tropical forests is needed to enhance model predictions of ecosystem responses to projected global environmental change.

O6-05 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

How much forest area should be sampled to get accurate biomass estimations?

RICO FISCHER, JESSICA HETZER, ANDREAS HUTH
Helmholtz Centre for Environmental Research – UFZ Leipzig, Ecological Modelling, 04318, Leipzig, Germany

Tropical forests play an important role in the global carbon cycle. Field inventory plots were used for understanding forest structure and dynamics at different scales under the assumption that these plots accurately represent their surrounding landscape. Here, we test whether inventory plots meet this assumption for biomass estimations in tropical forests. In a first step, we tested this assumption on a local scale. Using a large 50-ha forest inventory plot from Panama we analyzed how representative 1-ha subplots are for biomass estimations. Results show that about 6 of 1-ha subplots are needed to accurate estimate biomass for this region even at its most reliable sampling strategy. However, for accurate biomass estimations in less homogenous forest sites (such as disturbed forests or montane forests) the number of needed field plots increases by 60-80%. In a second step, we used larger data sets to test different sampling strategies for accurate estimates of forest biomass at regional scale. Results show that the required number of inventory plots is high. To overcome the limited number of inventory plots for accurate tropical forest biomass estimations the use of inventory plots in combination with high-resolution remote sensing products could be one promising solution.

O6-06 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Effect of population density of Cordia alliodora R. & P (Boraginaceae) in the functionality seedlings bank and understory diversity in the tropical dry forests. Colombia South America

OMAR MELO[1], SANDRA MARCELA CASTAÑEDA[2], FERNANDO FERNANDEZ[3]
[1]Universidad Del Tolima, Forestry Science, 73001, Ibague, Colombia
[2]Sena, Environmental, 130001, Cartagena, Colombia
[3]Universidad Del Tolima, Forestal, 73001, Ibague, Colombia

C. alliodora is a Neotropical tree. It presents a wide range of geographic dispersion ranging from northern Mexico, Central America and the Caribbean to Paraguay and northern Argentina in South America. In Colombia the species ranges from very humid regions, the Andean region to the tropical dry forests. The research was conducted in a fragment of tropical dry forest of 40 hectares, in an early successional stage set 20 years after livestock. Its coordinates are 5 ° 00'41.46 «N - 74 ° 54'55.50» O. The average annual rainfall is 1600 mm, the average temperature is 27 ° C. The average altitude is 375 m. The study area is part of the high Andean valley of Magdalena river in Colombia's central region. The objective was to evaluate the effect of population density of C. alliodora trees on the functionality of their seedlings and the understory diversity. Four treatments of population density were established: natural population over 700, 500, 300 and 100 trees per hectare. We use plots of 1.0 hectare with C. alliodora trees greater than 5.0 cm diameter at breast height (DBH). Trees of other species (47%) were not tapped. We measured photosynthetically active radiation (PAR), leaf area index (LAI) and factor of light extinction (K). Us we measure also net photosynthesis (A), specific leaf area (SLA), mortality, recruitment. Understory diversity was expressed using the Shannon – Wiener index. The results showed significant differences between treatments. The highest annual mortality of C. alliodora seedlings (28%) occurs in environments unmodified (PAR less than 18%, LAI of 3.4, K = 0.76). In this environment the diversity of undergrowth is 1.58. When the population density of the C alliodora trees is 300 trees per hectare the mortality is lowest (12%), the recruitment is 31%, the PAR is 27%, LAI is 2.1, K = 0.57 and diversity of the understory is the highest (H'= 2.17). Net photosynthesis was significant difference between treatments (6.2 to 7.9 mm.CO2.m2.s). Also significant differences for SLA were presented. Seedlings grown in environments with low PAR (18%) have lower SLA values (27.7). Seedling growing in environments with higher PAR (39%) have higher SLA (53.8). Changes to the population density of C. alliodora trees in secondary tropical dry forests can increase the understory diversity and affects the functionality of seedlings making them more acquisitive enabling their stay in the community.

O6-07 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

A size-structured, spatially explicit symmetric model of tropical rain forest predicts multiple community patterns at once

SEBASTIAN LEHMANN, ANDREAS HUTH
Helmholtz Centre for Environmental Research, Ecological Modelling, 04318, Leipzig, Germany

A potential way to explain the maintenance of species diversity within communities is provided by neutral models, where dispersal and demographic stochasticity are the main mechanisms which shape the structure of community structure. While previous attempts are mainly focused on the prediction of species-abundance distributions and species-area relationships, we incorporate the modelling of size-structured demography and symmetric conspecific regulation as community assembly mechanisms. We show in our study, that the linkage of reproduction, dispersal, mortality and growth through local density dependence successfully predicts a wide variety of macroecological patterns. This primary includes species-abundance distribution (SAD), species-area relationship (SAR), distance-decay and size distribution. Empirical evidence is given through a simultaneous fit of these patterns against the Barro Colorado Island (BCI) tree community. These results demonstrate the significance of size structure and conspecific effects in symmetric models.

O6-08 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Spatial prioritization for restoration of the Brazilian Atlantic Forest

BERNARDO STRASSBURG
International Institute for Sustainability, IIS, 22460-320, Rio de Janeiro, Brazil

Large scale restoration goals have recently been set at global and regional scales. The New York Declaration on Forests targets 350 million hectares globally, whereas Brazil´s national plan on aims for 12.5 million hectares nationwide. For the global biodiversity hotspot of the Atlantic Rainforest these goals present an unprecedented opportunity. The biome has only 12-18% of its original cover left, largely in highly fragment small remnants. Planned restoration targets could increase the native vegetation cover by as much as 50%, and, crucially, connect the remaining habitats. The benefits of this restoration, however, can vary greatly depending on its spatial arrangement. Here we simulate a large-scale restoration of the Brazilian Atlantic Forest Hotspot in order to: i) show the impacts of prioritizing (dynamic optimization) restoration under different scenarios, and ii) quantify the effects of scaling up projects (i.e. the economies of scale). We contrasted eight alternative scenarios and five economies of scale. We produced potential range maps for over 3,000 species of plants, birds and amphibians. We also produced a map of potential for natural regeneration, based on landscape, land-use and climatic variables, and the first map of restoration costs accounting for economies of scale of larger restoration projects. Our results show that benefits for biodiversity conservation vary greatly between scenarios, as does restoration costs. We also show that a multicriteria prioritization based on linear programming yield results that achieve significantly better conservation outcomes at smaller costs than random allocations. Our results will be used by the Brazilian Ministry of Environment as the official spatial prioritization maps for the Atlantic Rainforest, showing how early engagement with policy makers can improve the real-world impact of scientific projects.

O6-09 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Living at the edge: The impact of an introduced parasite and habitat change on the breeding success of Darwin's finches.

ARNO CIMADOM[1], PAUL SCHMIDT YÁÑEZ[2], CHRISTIAN SCHULZE[2], HEINKE JÄGER[3], SABINE TEBBICH[1]
[1]University of Vienna, Department of Behavioural Biology, 1090, Vienna, Austria
[2]University of Vienna, Department of Botany and Biodiversity Research, 1030, Vienna, Austria
[3]Charles Darwin Foundation, Charles Darwin Foundation, Puerto Ayora, Galapagos, Ecuador

Invasive parasites are a growing threat to biodiversity and can contribute to the extinction of endemic species. On the Galapagos Islands, the invasive parasitic fly Philornis downsi poses a major threat to the endemic avifauna. In a previous study, we showed that P. downsi had a strong negative impact on breeding success of two Darwin's finch species, the warbler finch and the small tree finch. An important habitat for both species is the last remnant of humid cloud forest on Santa Cruz Island. This forest relict has been invaded by introduced tree and shrub species which are currently being controlled with herbicides by the Galapagos National Park. Our data suggested that the control of invasive plants with herbicides had a significant additive negative impact on the breeding success (nests that produced fledglings). We hypothesized that the control of invasive plants leads to lower arthropod abundance as herbicide usage results in the temporary removal of the entire understory. We assumed that this reduces food supply during chick rearing, which in turn causes mortality in chicks that are already weakened by P. downsi.

In the present study we aimed at investigating the impacts of parasitism by P. downsi and invasive plant control with an experimental approach. We compared food availability and breeding success in three study sites that were affected by a varying degree of species invasion (heavily invaded areas, areas with long term management of invasive plants and recently controlled areas). Additionally, we manipulated P. downsi intensities in the finch nests by injecting insecticides, which enabled us to quantify the impact of parasitism at the three sites.

By eliminating P. downsi from finch nests, breeding success significantly increased from 5% to 60% at all three sites. Because of the overall low breeding success in 2015 due to drought conditions, we could not find a habitat management effect on the reproductive success of Darwin's finches. However, arthropod abundance was affected by invasive species control measures and was lower in areas which had been recently controlled.

Our experiments clearly confirm the detrimental effects of P. downsi on the breeding success of Darwin's finches. The measures to control invasive plants seem to have negative short term effects on different non-target species groups, like arthropods and bird species. However, preliminary results suggest long term benefits of the National Park's restoration efforts.

O6-10 – S6 *Free session: Experimental methods in tropical ecology*
Monday 20 June 20 / 14:30-17:30 – Sully3

Body condition and immune function is impaired by habitat disturbance in forest-dwelling paleotropical bats

ANNE SELTMANN[1, 2], MATTHEW STRUEBIG[3], GÁBOR-ÁRPÁD CZIRJÁK[4], HENRY BERNARD[5], CHRISTAN C.VOIGT[1], Christan C.VOIGT[2]
[1]Leibniz Institute for Zoo and Wildlife Research, Evolutionary Ecology, 10315, Berlin, Germany
[2]Freie Universität Berlin, Institute of Biology, 14195, Berlin, Germany
[3]University of Kent, Durrell Institute of Conservation and Ecology, CT27NR, Canterbury, UK
[4]Leibniz Institute for Zoo and Wildlife Research, Wildlife Diseases, 10315, Berlin, Germany
[5]Universiti Malaysia Sabah, Institute of Tropical Biology & Conservation, 88400, Kota Kinabalu, Malaysia

Zoonotic spillover events seem to result from an increased contact zone between wildlife and humans, for example when humans encroach into formerly pristine habitats. Yet, habitat deterioration may also negatively affect the physiology and health of wildlife species, e.g. by stress-related immune suppression, which my eventually lead to an increased shedding of potentially fatal pathogens. Here, we test in a paleotropical forest with ongoing logging and fragmentation, if habitat disturbance influences the body mass and immunology of bats, a taxon that was suggested as a major reservoir for highly virulent viruses. We measured and compared body mass, chronic stress and components of the cellular immune system of bats living in undisturbed, currently logged, and fragmented forests in Sabah, Malaysia. Chronic stress levels of bats, as indicated by the ratio of neutrophil to lymphocytes numbers, was higher in fragmented habitats compared to intact habitats in a cave-roosting species. Small, foliage-roosting species showed a reduced body mass and decrease in total white blood cell counts in disturbed habitats compared with conspecifics living in intact habitats. Our study highlights that habitat disturbance has species-specific effects on chronic stress and immunology that are potentially related to the roosting ecology and body size of bats.

O7-01 – S7 *The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest*
Monday 20 June 20 / 11:00-12:00 – Antigone1

Paleo-Precipitation patterns in South America during the last glacial-interglacial cycles: Implications for Amazon and Atlantic forest connections

CRUZ FRANCISCO
USP, Geosciences, 05508080, Sao Paulo, Brazil

During the last years a significant number of paleoclimatic reconstruction based speleothem isotope records have been produced for areas located within domain of Atlantic Rain Forest or areas where possible connection with Amazon forest might had occurred. Some of them are located in regions considered a center of endemism and of highest biodiversity along the Atlantic and Amazon Rainforest or between these biomes. Our results suggest that the long-term precipitation variability that follow changes in insolation and also increase ice-volume during Last Glacial Period have produced anti-phased pattern of precipitation. This pattern imply that forest corridors are not only restricted to large river valleys but it also occurred over vast areas. Because of contrasting rainfall distribution, the periods of forest connection were probably different in South America. In an attempting to confirm the climate conditions necessary for past forest connection between Amazon and Atlantic Forest, we are using new records from sites today covered by dry Savanna and dry forests in Brazil. Our results suggest that the climate favored forest expansion during glacial times in southern Atlantic Forest (AF) and Western Amazon. On the other hand, decreased precipitation occurred during most of last glacial period in northeastern Brazil and Eastern Amazon region which possibly caused rainforest fragmentation. However, some areas on coast of southern Bahia in Northeastern Brazil were sufficiently humid to maintain the rainforest preserved even under the driest periods during the Last Glacial Maximum.

O7-02 – S7 *The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest*
Monday 20 June 20 / 11:00-12:00 – Antigone1

Changes in the distribution and floristic composition of the Atlantic forest through time

LEDRU MARIE-PIERRE, VINCENT MONTADE, GRÉGOIRE BLANCHARD, CHRISTELLE HÉLY
Institut de Recherche pour le Développement, UM, CNRS, IRD, EPHE, Montpellier, France

To characterize changes in the spatial distribution of the Atlantic forest, we focused on three different forest physiognomies, evergreen, semi-deciduous, and Araucaria, during the last 17,000 years and we provide a list of indicator taxa for each class retrieved from the original published datasets. A review of published fossil pollen records allowed us to classify regional behaviors in three main areas of distribution, north of 15°S, between 15 and 23°S and south of 23°S latitude that correspond to three climatic geographical barriers. Statistical probability density function method was used to illustrate changes in forest physiognomies throughout the three distribution areas. We show that the three modern barriers also functioned through the past. Asynchronous patterns of forest physiognomies are linked to an antiphasing pattern of monsoon precipitation between the northern and central area, while in the southern area is linked to frequency and intensity of the polar advection in the subtropics. Our results attest to strong climate forcing on forest distribution between the late glacial and the interglacial period. They call into question the common reference to the last glacial maximum as a major (and sometimes as the only) driver of forest-related vicariance and genetic diversity patterns, but suggest that instead, orbital cycles were the main drivers of the successive expansion / contraction of the Atlantic forest throughout the Quaternary.

O7-03 – S7 *The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest*
Monday 20 June 20 / 11:00-12:00 – Antigone1

Sub-genomic data shed new light on species response to climate change in the South American rainforests

CARNAVAL ANA CAROLINA
City University of New York, Biology, 10031, New York, United States

Background. Paleoecological studies suggest that humidity has been a major constraining element of Neotropical forest distribution in the Quaternary. Through a compilation of speleothem and fossil data, it has been proposed that levels of rainfall in the eastern portion of Amazonia dynamically matched those in the northern Atlantic Forest, while precipitation patterns in western Amazonia have been linked to those in the southern Atlantic Forest. These two macroclimatic systems have been presumably acting as a dipole, with multiple cycles of inversion of precipitation regimes between regions.
Methods. Using reduced genomic (SNP) data from lizards co-distributed in Amazonia and the Atlantic Forest (Anolis punctatus, A. ortonii, and Polychrus marmoratus), this study asked whether phylogeographic patterns in widely distributed forest animals match the proposed out-of-sync precipitation dynamics. To test for spatial congruence of demographic changes, geographic and genetic data were combined to identify the geographic origin of population expansions. Temporal congruence of demographic changes (synchronous shifts in population size change) was assessed through coalescent simulations under a hierarchical demographic model, in combination with Approximate Bayesian Computation (ABC). Further exploring the molecular data and their potential contribution to conservation, a new framework was applied to spatially model the plausible distribution of genomic diversity of both Anolis species under future climates. For this, species-specific demographic parameters were inferred from a combination of species distribution models, forward-in-time demographic simulations, and backwards-in-time coalescent simulations that were compared to the empirical SNP data.
Results and Discussion. The results supported population shifts within the timeframe of proposed moisture fluctuations (last 250 ky), but idiosyncratic responses are detected among species. Models of genomic patterns of diversity under a future climate scenario predicted very distinct trajectories between species, resulting from different population densities and capacities of dispersal inferred from the SNP data. Together, the analyses suggest that differences in ecological and demographic constraints lead to idiosyncratic responses to common environmental change, even in ecologically similar species, and help explain how environmental factors shape tropical community assembly - in the past and in the future.

O7-04 – S7 *The assembly and evolution of the neotropical biota: the role of biotic exchanges between amazonia and the atlantic forest*
Monday 20 June 20 / 11:00-12:00 – Antigone1

Tempo and mode of biotic interchanges between Amazonia and the Atlantic Forest domains: evidence from multiple plant clades

LÚCIA LOHMANN, RENATO MELLO-SILVA, LUIZ HENRIQUE FONSECA, JUAN PABLO NARVÁEZ-GÓMEZ, JOSÉ RUBENS PIRANI
Universidade de São Paulo, Departamento de Botânica, 05508-090, São Paulo, Brazil

Background: Tropical America is the most species rich region on Earth. Understanding the processes that shaped this Biota requires a deep understanding of past geological events and knowledge of phylogenetic relationships. Here, we review what is known about the tempo and mode of botanical interchanges between the two major domains in South America, Amazonia (AM) and the Atlantic Forest (AF). We analyze this data in the light of the past geological history, and discuss potential implications of these interchanges for the assembly of the Neotropical biota. Through this study we assemble a new dataset that allowed us to test some of the current hypotheses about the existence, extension and duration of past connections between these domains.
Methods: We used the dataset compiled by BFG (The Brazil Flora Group, 2015) for the checklist of the Brazilian plants to identify shared taxa between AF and AM. This checklist includes 32,109 seed plants, 15,001 of which occur in the AF and 11,896 in AM. We then searched for time-calibrated phylogenies of taxa shared between the AF and AM in published papers from the last 20-years. We recorded the size of clades, sister-taxa, respective sister-areas, and ages of diversification, as well as categorized species into biographically informative units and generated graphic representations of area connections across clades. We summarized this data and determined the timing and most common routes of biotic interchanges between the AF and AM.
Results: An initial survey indicated that ca. 1370 plant species are shared between the AF and AM. Of these, ca. 370 species are shared between the AF and AM exclusively, while ca. 875 species are also shared with dry domains such as Caatinga and Cerrado, and ca. 125 species are also shared with Pampas and Pantanal. Various plant families provided key insights into the tempo and mode of biotic interchanges between the AF and AM, namely Annonaceae, Bignoniaceae, Fabaceae, Lecythidaceae, Lauraceae, Melastomataceae, Myrtaceae, Rubiaceae, and Rutaceae, among others.
Conclusion: Our botanical knowledge has advanced considerably in the past years. Multiple time-calibrated phylogenies are now available, allowing us to test hypotheses about the tempo and mode of biotic interchanges between AM and AF. These analyses indicate that these biotic interchanges have a complex history, having occurred multiple-times, through multiple-routes, and at different times since the Paleogene.

O8-01 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

What commodity is the most important driver of tropical deforestation?

BOUCHER DOUG
Union of Concerned Scientists, Climate and Energy, 20842, Dickerson, USA

Background: While scientists have realized in the past decade that commodity agriculture is the leading driver of tropical deforestation in the twenty-first century, data indicating the relative importance of different commodities -- e.g. beef, soy, palm oil and wood products -- has only recently become available.
Methods: I reviewed recent estimates of how much deforestation is driven by different commodities (Henders, Persson, DeSy et al.) and compared them to each other, to estimates of pantropical deforestation (FAO, Achard, Tyukavina, Zarin et al.) and to estimates of the non-deforestation greenhouse gas emissions associated with each commodity. I also used these data to estimate the degree to which the globalization of food and agriculture -- due both to international trade and to global diet shifts -- has caused twenty-first century deforestation. In order to standardize comparisons, I used greenhouse gas emissions (CO2eq/year) as the basic unit of measurement for deforestation.
Results: The recent estimates show clearly that commodity agriculture -- not small-scale peasant production for subsistence -- is the leading driver of deforestation in the twenty-first century. Among the major commodities linked to deforestation, beef is a much more important driver than the other three (soy, palm oil and wood products). This is related to its extremely inefficient use of land to produce food (low biomass and food yield per hectare). Beef is also the largest generator of non-deforestation greenhouse gas emissions, due to its producing methane and nitrous oxide from enteric fermentation and manure. Unlike the situation with the other commodities, most beef is consumed domestically rather than entering into international trade.
Conclusion: The most important driver of tropical deforestation in the twenty-first century is beef. Additionally, it is also the leading source of direct agricultural emissions. The globalization of commodity agriculture has played an important role in driving deforestation, but its impact has operated more through diet change rather than directly through international trade.

O8-02 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Conserving landscapes, species and cultures in Papua New Guinea

CUTHBERT RICHARD
Wildlife Conservation Society, Papua New Guinea Programme, 441, Goroka, Papua New Guinea

Background: Papua New Guinea (PNG) is the world's most culturally diverse nation with over 840 recorded languages and cultures. PNG's cultural diversity is matched by its biological diversity, with an estimated 8% terrestrial biodiversity within less than 1% of the world's land area. However, PNG is changing and with a rapidly increasing population of 7 million people and further demands being placed on the natural systems by local communities and extractive industries there is an increasing threat to the country's species and landscapes.
Methods: We partnered with customary landowners on Manus Island and in Chimbu Province to address deforestation (from logging companies and local communities) and the hunting of the Admiralty Cuscus (Spilocuscus kraemeri) and New Guinea Vulturine Parrot (Psittrichas fulgidus). We addressed these issues through understanding and revitalizing land tenure systems and customary resource management of wildlife, along with innovative conservation science and community projects.
Results: Understanding land tenure systems and undertaking free prior and informed consent with local communities was an essential first step for developing conservation solutions on Manus Island, and led to the development of community development projects and agreements for forest conservation. Revitalizing interest in traditional "tambu" (no-take) areas proved an effective means of developing a sustainable harvest of Admiralty Cuscus on Manus. Our work on the Vulturine Parrot revealed the cultural importance in traditional costumes in PNG and the scale and extent of the threat to this species. Through developing simple methods to extend the life of feathers in costumes and revitalize traditional links between the use of the species and its cultural importance we gained support for these conservation actions.
Conclusion: The complexity of PNG means that a thorough understanding of the local context and cultural processes are essential for making informed decisions about conservation and natural resource management. Conservation projects that met the interests and needs of local communities and that revitalized customary processes and management options appear most likely to gain traction in PNG. This approach offers a plausible and culturally appropriate alternative to western concepts of conservation in the PNG that have had mixed results at protecting the country's unique biological and cultural diversity.

O8-03 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Living with the enemy; crop raiding in Brazilian Amazonia

MARK ABRAHAMS[1], CARLOS PERES[1], HUGO COSTA[2]
[1]The University of East Anglia, Environmental Science, nr5 7tj, Norwich, UK
[2]Universidade Federal do Para, Ciências Biológicas, CEP 66075-110, Belem, Brazil

Introduction - Tropical smallholders, amongst the world's monetarily poorest people, are exhorted to preserve their megadiverse surroundings and bear significant costs. Yet damage to staple crops by forest wildlife (crop raiding) strains precarious livelihoods. We quantified the degree of crop raiding damage to manioc (M. esculenta) plantations in the Medio-Jurua region of Brazilian Amazonia, implicate its protagonists and explain its prevalence.
Methods - We deployed 133 camera trap stations in the neighbourhood of 48 local communities, consisting of several land-cover classes; and conducted 45 semi-structured and 107 structured interviews focused on livelihood, diet, agriculture and crop raiding. Structured interviewees were asked about up to four of their roçados (agricultural fields).
Results - Across 238 roçados, mean reported losses to crop raiders was 7.73 ± 1.01%. The most frequently reported terrestrial vertebrate crop raiders were frequently hunted and amongst the species most detected by camera traps, especially in disturbed habitats. Community size (N households) and proximity to undisturbed habitat negatively affected crop-raiding rates at the roçado scale. Community size and proximity to the nearest urban center negatively influenced the amount of manioc raided. A higher biomass of crop raiders was detected in disturbed habitats and associated with smaller communities. Responses to crop raiding were split roughly equally between lethal and nonlethal methods. Interviewees estimated that losses to crop raiders would be 70.6 ± 3.4% in the absence of crop protection.
Conclusion - Crop raiding losses are a significant cost to local forest dwellers coexisting with high biodiversity. Modest mean losses mask occasional devastation. Agriculture was the most important livelihood activity and farmers invested significant amounts of time and energy in protecting their fields to prevent tenfold losses. 'Win-win' opportunities to cull crop raiders offer little compensation as hunting was a less important livelihood activity than farming, hunted meat comprised a smaller proportion of the protein diet than fish, and the most hunted species were not necessarily the worst crop raiders.

O8-04 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Is the multifunctional use of wetlands compatible with African bird conservation?

LYNDA DONALDSON[1], ANNA J WOODHEAD[1], ROBERT J WILSON[2], ILYA MD MACLEAN[1]
[1]University of Exeter, Environment & Sustainability Institute, TR10 9FE, Penryn, UK
[2]University of Exeter, Bioscience, EX4 4PS, Exeter, UK

Background: Conservation managers traditionally advocate measures that limit disturbance caused by human activity. However, natural forms of disturbance are an important component of many ecosystems and their associated species are often adapted to such regimes. As a result, modern conservation management often involves the simulation of natural disturbance, particularly in temperate forest systems. This practice is less widespread and seldom studied in the tropics, where human activities and biodiversity conservation are commonly thought to conflict. Nevertheless, many tropical systems have been exposed to natural and anthropogenic disturbance over long periods of time, and in consequence disturbance could benefit the species hosted by these habitats. Determining if this is the case is likely to be especially key in wetland environments, where human activities are essential for sustaining local livelihoods.
Methods: We investigate the impacts of disturbance from human resource use on habitat specialist bird species endemic to papyrus (Cyperus papyrus) swamps in East and Central Africa. Bird densities were established from point count surveys conducted at swamps surrounding Lake Bunyonyi, southwest Uganda. Physical characteristics of wetland vegetation indicative of disturbance were used to determine the effect of human activities on the density of each species.
Results: All species were tolerant to some degree of disturbance, with some species occurring at highest density in the presence of intensely disturbed habitat, while the remaining species were unaffected by the presence of disturbed vegetation. Species were generally more tolerant to disturbance, having broader habitat requirements, in larger swamps.
Discussion: The results of this study suggest that the low intensity multifunctional use of natural resources by people can be compatible with the conservation of specialist bird species in tropical habitats with long histories of disturbance. The conservation of wetlands need not involve the alienation of those who depend on the resources they provide. On the contrary, such activities may benefit biodiversity and can be incorporated into the conservation management of tropical wetlands; creating a win-win situation for both wildlife and people.

O8-05 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Fine root biomass along an elevational and land use gradient in Mt. Kilimanjaro

NATALIA SIERRA CORNEJO, DIETRICH HERTEL
University of Goettingen, Ecology and Ecosystem Research, 37077, Goettingen, Germany

Assessment of carbon pools and fluxes in forest ecosystems are of key importance in the mitigation of global change effects. Fine roots are a main component of the carbon and nutrient cycle in forest ecosystems due to their high turnover rates and high biological activity, although they contribute little to the carbon stocks.
Fine root biomass in forest ecosystems is controlled by environmental factors and stand characteristics. Increment in elevation normally entails lower decomposition rates, driving to nutrient limitation and the consequent increase on fine root biomass. In tropical montane forest it has been shown that the shoot: root ratio decreases with elevation. There is a swift in the allocation of carbon from the aboveground organs to the root system, which becomes of greater importance in higher elevations. On the other hand, land use change affects forest structure and species composition, presenting important consequences on carbon pools. A decrease in fine root biomass with land use intensity has been assessed.
There is a lack of information about fine root biomass in tropical ecosystems, especially referring to the African continent. We study fine root biomass up to 40 cm depth in soil in Mount Kilimanjaro, as it presents a wide elevation range (866-4550 m) covering important natural habitats and different disturbed habitats with increasing land use intensity. Our study design consists of 5 replicates of 12 different habitat types (6 natural and 6 disturbed).
This study focuses on the following hypothesis: (1) Fine root bio- and necromass increases with elevation until the afroalpine vegetation. (2) Changes in vegetation structure in the afroalpine zone decrease fine root biomass, although the shoot: root ratio increases in response to nutrient limitation conditions. (3) Land use change presents a negative relation with fine root biomass.
Our objectives are: (1) to quantify the contribution of the fine root biomass to the carbon pool of natural and disturbed habitats in Mount Kilimanjaro, (2) to analyze the effects of elevation and land use change on fine root biomass, and (3) to assess if there is a swift in the carbon allocation from aboveground parts of the plants to the root system with the elevation.
Preliminary results and conclusions will be presented to better understand patterns in carbon cycle in tropical ecosystems and to enhance conservation on Mount Kilimanjaro.

O8-06 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Effects of land-use and climate on seed-dispersal networks on Mt. Kilimanjaro, Tanzania

MAXIMILIAN VOLLSTÄDT[1], MATTHIAS SCHLEUNING[1], KIM HOWELL[2], MARCO TSCHAPKA[3], ANNA VOGELER[3], KATRIN BÖHNING-GAESE[1]
[1]Senckenberg, Biodiversity and Climate Research Centre (BiK-F), Frankfurt am Main, Germany
[2]University of Dar es Salaam, Department of Zoology and Wildlife Conservation, Dar es Salaam, Tanzania
[3]University of Ulm, Institute of Evolutionary Ecology and Conservation Genomics, Ulm, Germany

Land-use and climate change pose threats to biodiversity worldwide and especially in tropical ecosystems.
Many studies show the effects of these drivers of global change on species richness, but less studies investigated the effects of global change on ecosystem functions by animals. For instance it is poorly understood, how land-use and climate can influence mutualistic interaction networks between plants and their animal seed dispersers.
To our knowledge, the present study is the first to simultaneously investigate how land-use and climate affect seed-dispersal networks of fleshy-fruited plants and birds in a tropical environment. We recorded seed-dispersal networks in 10 different habitat types (ranging from pristine to highly disturbed habitats) and at 4 elevational belts (800 – 3000 m asl) on Mt. Kilimanjaro, Tanzania.
Our preliminary results show that seed-dispersal networks were more specialized at the extremes of both the land-use and climatic gradient. Specialization of the networks decreased with increasing plant diversity, suggesting that high network specialization was primarily a response of seed dispersers to low resource diversity. The high specialization in habitats with high human impact and harsh climates suggests a low tolerance of avian seed-dispersal to species loss in these environments.

O8-07 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

The fate of Thailand's tropical birds under the synergistic impacts of climate change and land use change

NANTIDA SUTUMMAWONG[1], STEPHEN E. WILLIAMS[1], YONGYUTH TRISURAT[2]
[1] James Cook University, Centre of Tropical Biodiversity and Climate Change, 4814, Townsville, Australia
[2]Kasetsart University, Forestry, 10900, Bangkok, Thailand

The synergistic interactions between climate change and land use change represents one of the most important threats to global biodiversity. Many tropical bird species have already shifted their distributions in response to climate change, but few studies predict the synergistic impacts of land use change and climate change to biodiversity. Southeast-Asia represents a globally-significant biodiversity hotspot that is particularly threatened by the combination of habitat degradation and climate change. This study aims to assess the potential impact of range changes and variations in species richness under future climate scenarios combined with future land use and land cover (LULC) scenarios. Maximum entropy modeling was employed to project change in the distributional area of 305 species for the year 2050 and 2070, utilizing four different IPCC future climate scenarios combined with four regional land use scenarios to denote different magnitudes of stressors. Results varied by species, but in general, model accuracy of all predictors; climate-only, climate-LULC, and LULC-only; was excellent. Change in range distribution was poorest under the combination of high emission climate scenario (RCP 8.5) and LULC scenario of unsustainable economic development and serious resource degradation. Large decrease in species richness was predicted for lowland parts of Thailand and increases were found for highland areas of western Thailand that tracked higher forest cover associated with protected areas. We conclude that species respond differently to climate and LULC variables, however, the simultaneous action of climate combined with LULC have a greater total effect than the sum of individual effects alone, demonstrating synergistic impacts of climate change and land use change as a key threatening process that should be addressed for avifauna conservation initiatives.

O8-08 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Lattice-work corridors for climate change: a conceptual framework for biodiversity conservation and social-ecological resilience in a tropical elevational gradient

PATRICIA TOWNSEND[1], KAREN MASTERS[2]
[1]Washington State University, Advanced Hardwood Biofuels Northwest Program, 98201, Everett, WA, USA
[2]Council on International Educational Exchange, Program in Sustainability and the Environment, 5655, Monteverde, Costa Rica

Rapid climate change poses complex challenges for conservation, especially in tropical developing countries where biodiversity is high while financial and technical resources are limited. The complexity is heightened by uncertainty in predicted effects, both for ecological systems and human communities that depend heavily on natural resource extraction and use. Effective conservation plans and measures must be inexpensive, fast-acting, and able to increase the resilience of both the ecosystem and the social-ecological system. We present conservation practitioners with a framework that strategically integrates climate change planning into connectivity measures for tropical mountain ecosystems in Costa Rica. We propose a strategy for doubling the amount of habitat currently protected in riparian corridors using measures that are relatively low cost and fast-acting, and will employ and expand human capital. We argue that habitat connectivity must be enhanced along latitudinal gradients, but also within the same elevational bands, via a lattice-work corridor system. This is needed to facilitate range shifts for mobile species and evolutionary adaptation for less mobile species. We think that conservation measures within the elevational bands must include conservation-friendly land uses that improve current and future human livelihoods under dynamic conditions. Key components include community involvement, habitat priority-setting, forest landscape restoration, and environmental services payments. Our approach is fundamentally adaptive in that the conservation measures employed are informed by on-the-ground successes and failures and modified accordingly, but are relatively low risk and fast-acting. Our proposal, if implemented, would satisfy tenets of climate-smart conservation, improve the resilience of human and ecological communities, and be a model for other locations facing similar challenges.

O8-09 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Oil in tropical rainforests revisited: a major threat to their future?

MARTI ORTA-MARTINEZ[1], PEDRO MAYOR[2]
[1]Erasmus University Rotterdam, International Institute of Social Sciences, 2518 AX, Deen Hague, The Netherlands
[2]Autonomous University of Barcelona, Dept. Sanitat i Anatomia Animals, 08193, Bellaterra, Spain

South America is a critical region at risk of ecosystem destruction and biodiversity loss from increasing Fossil Fuel extraction (Butt et al 2013). Petroleum is being extracted from tropical rainforest in Southeast Asia, Central Africa and South America. This is considered a strategic source of national revenues and growing oil global demand have stimulated a growth in hydrocarbon-related activity. Only in the Peruvian Amazon, over 540,000 km^2 have already been tapped for oil and gas.
There is currently a debate on the exploration and exploitation of oil resources in pristine tropical rainforests and the controversial compatibility between oil activities and their conservation. In this paper the authors conduct a systematic review of the scientific literature on environmental impacts of oil and gas exploration and exploitation in tropical rainforests. The authors conclude that, arguably, the debate is hampered by a dearth of scientific data on the impacts of such activities. The authors also point out the highly variable national regulatory frameworks of the various tropical countries regarding the compatibility between oil extraction, and the protection of natural areas, indigenous lands and territorial reserves for indigenous people living in voluntary isolation. A rigorous scientific analysis of potential impacts is urgently needed as the Amazon and the other rainforests have been set to face a dramatic increase in hydrocarbon-related activity.

O8-10 – S8 *Free session: Land use, landscape ecology, and conservation*
Monday 20 June 20 / 14:30-17:30 – Antigone1

Wildlife and their Preferred Habitats in Selected Key Mining Areas of Mindanao: Basis for Policy Reform and Biodiversity Conservation

SHERRYL PAZ[1], MARIA TEODORA CABASAN[2], CORDULO ASCANO[3], ROXAN EUPENA[4], CINDERELLA RAGANAS[1], ANGELO AGDUMA[2], JHONNYWYNNE EDANO[2], AARON FROILAN RAGANAS[2], DENNIS MUGOT[5], VICENTA ANSIGBAT[3], QUEENILYN ALBUTRA[3], ADAM ROY GALOLO[1], NEIL ALDRIN MALLARI[6]
[1]Caraga State University, Natural Sciences, Environmental Science Division, 8600, Butuan City, Philippines
[2]University of Southern Mindanao, Biology, Cotabato, Philippines
[3]Mindanao University of Science and Technology, Environmental Science and Technology, Cagayan de Oro City, Philippines
[4]Surigao del Sur State University, Education, Tandag City, Philippines
[5]Misamis Oriental State College of Agriculture and Technology, Arts and Sciences, Claveria, Philippines
[6]Fauna and Flora International - Philippines, Cavite, Philippines

Mindanao Island is one of the centers of endemism and is called the "Mining Capital" of the Philippines. The mining concessions are proliferating in the Eastern Mindanao Biodiversity Corridor which is known to harbor the largest remaining blocks of tropical lowland rainforest. However, terrestrial biodiversity and their habitat associations in mining areas on the island are scarcely studied. In this research, habitat characteristics across various habitat types, responses of terrestrial flora and fauna to habitat conditions were assessed in the Northeastern, Northwestern and Southern parts of Mindanao. The sampling sites in the Northeastern and Southern parts are mostly early secondary forests with some advanced secondary forest patches while sites in the Northwestern part are mostly agricultural areas and grassland. A total of 1,316 species of flora (trees, shrubs, herbs, vines, ferns and bryophytes) and fauna (birds, amphibians, reptiles, volant and non-volant mammals) were recorded during the surveys in selected key mine areas of Mindanao. There were 203 Philippine-endemic and 26 Mindanao-endemic flora and fauna recorded of which 11 are critically endangered flora, 13 endangered flora and fauna, 58 vulnerable and 29 near-threatened. Canonical Correspondence Analysis (CCA) showed that most of the key tree and bryophyte species are forest dependent while most of the selected non-tree key species are associated with degraded forest habitats although most of them are known to be true forest dwellers or remnants of forests. The threatened endemic birds and most of the key volant mammals prefer forests. Herps are associated with forests while others prefer to be in the forest edge. Species distribution models revealed that primary high conservation value areas (HCVAs) for selected forest-dependent terrestrial flora and fauna are located mostly in the eastern parts of Mindanao where mining concessions are overlapping with mature forests. The study suggests urgent need to conserve the remaining forested patches in mine areas of the island. Proper conservation strategies of the forest specialists through policy reform, effective information and education communication and proper coordination among concerned stakeholders towards regulating mining and agricultural expansion are highly recommended. Moreover, the identified primary HCVAs may require further research and discussion with stakeholders to improve governing laws and policies for its implementation.

O9-01 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Reconstructing growth trends from tree-ring data: can we account for biases?

PIETER ZUIDEMA[1], PETER GROENENDIJK[2], MART VLAM[1], PETER VAN DER SLEEN[3], RICHARD PETERS[4]
[1]Wageningen University, Forest Ecology and Forest Management, 6700 AA, Wageningen, the Netherlands
[2]Universidade de Santiago de Compostela, Departamento de Botánica, 27002, Lugo, Spain
[3]University of Texas, Marine Science Institute, TX, Port Aransas, US
[4]Swiss Federal Research Institute for Forest, Snow and Landscape Research, Landscape Dynamics, CH-8903, Birmensdorf, Switzerland

There is a great need to predict responses of tropical forests to future climate change. One way of obtaining valuable insights about climate-forests relations is by studying forest responses to past climatic changes. Tropical tree-ring analysis is a powerful tool to obtain such insights, as wood contains archives of physiological and growth responses of trees to past climatic changes. Tree-ring studies have the potential to greatly extend the temporal scale of tropical forest studies: from years or decades, typical for plot-based or remote-sensing studies, to centuries.
Yet, one of the important challenges in tropical tree-ring studies is that trees alive today may be a non-random sample of trees that lived in the past. When tree-ring studies are used to infer effects of gradual changes in environmental or climatic conditions (CO2, temperature, rainfall, nutrients) on tree growth, it is important that historical growth trends are not altered by sampling strategy, statistical methods or selection processes within the studied population.
We present, evaluate and discuss five possible biases in tree-ring records that may mask actual growth trends or produce spurious growth trends. (1) The big-tree sampling bias may occur when only large trees are sampled, which may induce spurious growth increases over time. (2) The slow-grower survivorship bias may occur if slow growers have a markedly higher survival probability and are therefore overrepresented further back in time. (3) The juvenile selection bias is the reverse of the previous bias: it may alter reconstructed growth trends if fast growers have a higher probability of surviving to large sizes. (4) The pre-death suppression bias may lead to slower reconstructed growth rates in the recent past, if tree death is preceded by slow growth. (5) The scarce recruitment bias may influence growth trends if recruitment has been absent for some time in the recent past.
We show and discuss ways to deal with each of these five biases, and illustrate this using tree-ring data obtained from 13 tropical tree species. We show that some potential biases can be avoided by sampling schemes in the field, while others can be accounted for statistically or by restricting analyses to certain periods. We conclude that (1) growth trend studies need to explicitly account for possible biases, (2) tree-ring analysis provides a powerful tool to reconstruct growth trends, but (3) these growth trends need to be interpreted cautiously.

O9-02 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Woody biomass production lags stem-girth increase by over one month in temperate forests: what to expect for the tropics?

CUNY HENRI
Swiss Federal Research Institute WSL, Landscape Dynamics, CH-8903, Birmensdorf, Switzerland

Background: Wood is the main terrestrial biotic reservoir for long-term carbon sequestration, and its formation in trees consumes around 15% of anthropogenic carbon dioxide emissions each year. However, the seasonal dynamics of woody biomass production cannot be quantified from eddy covariance or satellite observations. As such, our understanding of this key carbon cycle component, and its sensitivity to climate, remains limited.
Methods: We performed high-resolution cellular based measurements of wood formation dynamics in three coniferous forest sites in north-eastern France over a period of 3 years.
Results: We show that stem woody biomass production lags behind stem-girth increase by over 1 month. We also analyse more general phenological observations of xylem tissue formation in Northern Hemisphere coniferous forests and find similar time lags in boreal, temperate, subalpine and Mediterranean forests. In the well-watered French sites the seasonal dynamics of stem-girth increase matched the photoperiod cycle, whereas those of woody biomass production closely followed the seasonal course of temperature.
Discussion: The revealed time lags question the extension of the equivalence between stem size increase and woody biomass production to intra-annual time scales. They also imply that these growth processes exhibit differential sensitivities to local environmental conditions. Consequently, we suggest that forecasted changes in the annual cycle of climatic factors may shift the phase timing of stem size increase and woody biomass production in the future. Finally, the results of this study were obtained in coniferous forests of the Northern Hemisphere. However, we argue that it is important to reach a more in-depth understanding of the dynamics and climatic sensitivity of woody biomass production also in tropical forests, which form an important element of the global carbon cycle. Different results are expected in such ecosystems, where more complex seasonal dynamics of wood formation and wood structures are observed, and where seasonal climatic variations are dominated by other factors.

O9-03 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Current tree-ring research and potential in tropical Africa: case-study on commercial timber species from the Democratic Republic of Congo

MAAIKE DE RIDDER[1,2], JAN VAN DEN BULCKE[2], NILS BOURLAND[1,3,4], CÉDRIC ILUNGA[1,5], EMMANUEL KASONGO[1,5], JORIS VAN ACKER[2], HANS BEECKMAN[1]
[1]Royal Museum for Central Africa, Wood Biology Service, 3080, Tervuren, Belgium
[2]Ghent University, Department of Forest and Water Management, 9000, Ghent, Belgium
[3]CIFOR, na, 16115, Bogor, Indonesia
[4]R&SD, na, 048581, Singapore, Singapore
[5]Université de Kisangani, Faculté des Sciences, na, Kisangani, Democratic Republic of Congo

Background: Although many dendrochronological studies in the tropics were successful, studies in the Democratic Republic of Congo remain scarce. Consequently, quantitative growth data are needed to estimate the effects of climate change and document sustainable forest management. Forest exploitation is limited to about 20 tree species of which light-demanding long-lived pioneer species represent the largest volumes on the market. Fortunately, most of these light-demanding tree species are known to form annual tree rings but crossdating is only performed on a limited number of these. This study focuses on tree rings of four Congolese timber species which are rarely used in dendrochronology.
Method: Using classical dendrochronological methods on stem disks and increment cores, we will describe the anatomical structure of tree rings, measure tree rings and construct tree-ring chronologies by crossdating tree-ring series of Pericopsis elata (afrormosia), Entandrophragma cylindricum (sapelli), Milicia excelsa (iroko) and Terminalia superba (limba). Growth responses to climate were analyzed. If evidence is lacking, cambial pinning was performed to confirm the annual character of tree rings. Logging parameters such as the minimum logging diameter were simulated when inventory data were available.
Result: Tree-ring boundaries are annual in all trees and the presence of a marginal (discontinuous) parenchyma band appears the common indicator for tree-ring demarcation. Although intra-tree crossdating was effective, inter-tree crossdating was sometimes difficult. For species with a tree-ring chronology, growth responses to climate were species-specific and no common growth response was observed. For P. elata and T. superba, the simulated logging parameters suggest that current cutting diameters are not hampering sustainable wood production.
Discussion/conclusion: Although we were not able to construct tree-ring chronologies for all study species, the potential of African tree-ring studies is obvious. More samples will help in better unravelling the common growth signal. Therefore, collaborations with forest logging companies are starting up and could eventually lead to more tree-ring chronologies including commercial species like Entandrophragma utile (sipo), Erythrophleum suaveolens (tali)... Although tree-ring analyses appear time-consuming, this method can be considered a price-friendly and fast alternative for periodical inventories of permanent sample plots.

O9-04 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Understanding plant growth dynamics: links between morpho-anatomical structure and phenology

YVES CARAGLIO[1], DANIEL BARTHÉLÉMY[1], CLAUDE EDELIN[2], ERIC NICOLINI[1], PATRICK HEURET[3]
[1]CIRAD, Umr AMAP, 34398, Montpellier, France
[2]CNRS, IFP, 605001, Pondicherry, Inde
[3]INRA, Umr ECOFOG, 97310, Kourou, France

The scientific community explores numerous issues surrounding the carbon storage of tropical forest ecosystems, taking allometric or functional approaches. There is growing interest in the relations existing between climate change and fluctuations in the functioning of forests, in the leaf phenology of species, and in the relations existing between phenology and wood. Because the trunk constitutes the main biomass of the tree, growth is essentially view in terms of diameter and in height, in a letter. The morpho anatomical structure of stem axes, bearing the leaves and underlying the spatial occupation of plants, is seldom considered. Understanding how the system of tree axes is deployed (primary growth, acquisition of resources) and grows (secondary growth, support, translocation and storage) remains a challenge in carbon sequestration issues, but also in those related to forest dynamics.
The fundamentals of plant architecture can be found in stem morphology (growth processes, branching, etc.) and the natural levels of organization, such as the axis and the phytomer. Some more temporal levels exist (growth unit, module), and others that are more integrating (architectural model, architectural unit), along with reiterated structures. Methods exist for gaining access to this structural information: monitoring to check the temporal aspect of structure formation; retrospective analysis of plant structure.
Reconstructing past development of trees, by combining, in an original manner, the phenology of elongation and thickening on the scale of small branched systems up to the whole plant, reveals the relations existing between leafy shoots, flowering, branching and diameter growth. A comparison with climate data reveals the most susceptible structural variables for a given factor. Architecture plasticity is analysed in terms of balances between leaf/axis (exploitation/exploration of space), elongation/thickening (exploration/support) and brings out some architectural traits and strategies of the tree throughout its ontogeny.
The architectural approach provides a conceptual framework for sampling and integrating large trees. The spatial phenology of primary and secondary growth makes it possible to address the rules of prioritization in response to constraints. This dual approach will involve taking another look at biomass and forest ecology matters (colonization of the environment, invasive plants, reforestation).

O9-05 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Studying phenology of tropical forest trees using a morphological and anatomical retrospective analysis: the case of Moronobea coccinea Aubl. (Clusiaceae)

HÉLÈNE MOREL[1], THOMAS MANGENET[2], PATRICK HEURET[3], ERIC NICOLINI[4]
[1]CIRAD, UMR EcoFoG, 97379, Kourou, French Guiana
[2]CIRAD, UMR AMAP, 34398, Montpellier, French
[3]INRA, UMR EcoFoG, 97379, Kourou, French Guiana
[4]CIRAD, UMR AMAP, 97379, Kourou, French Guiana

Most studies on tropical plant phenology have focused on patterns of flowering, fruiting and leaf-shedding. They are based on time-consuming continuous surveys over seasons or years and the basic considered scale is the tree integrated within a population or a community. So, the functioning of the different axis categories inside the crown of one individual have been poorly considered and studied. Here, we want to demonstrate the efficacy of a retrospective analysis based on morpho-anatomical growth markers coupled with a field survey to study phenology and growth at different scales from within-individual to populations.
In French Guiana, we collected dominant branches from 5 Moronobea coccinea adults, a hemi-tolerant tree of Neotropical rain forests. We identified growth markers delimiting longitudinal and radial increments. We coupled this retrospective analysis with a 30-month survey of (i) leaf-shedding and primary growth on twenty-two trees every month and (ii) for the repeated collecting of microcores from five trees every fifteen days to determine intra-annual cambial activity (i.e. formation of secondary xylem).
Successive growth units and growth rings were identifiable based on morpho-anatomical markers. These structural regularities traduce the phenological cycle defined by leaves shedding, growth-unit elongation and growth-ring formation. The retrospective analysis was few time consuming and in comparison we reconstructed the tree growth history of individual trees in only two weeks. Our study shows that retrospective analysis and field survey are two complementary approaches to understand plant phenology and to interpret morpho-anatomical structure. Dating a branch by counting the number of growth units or growth rings is possible in many years with a reasonable error. Nevertheless, estimating their precise month of formation in order to study climatic influences remains difficult if a growth monitoring isn't coupled in the same time.
The cycle of M. coccinea is essentially a biennial, with some slight variability: first year, the trees shed their leaf whereas the following years, trees flowers. At the population scale, trees were unsynchronized and the relationship between primary and secondary growth aren't clear. Surprisingly, we found an asynchronous phenological cycle between axes mainly due to flowering.

O9-06 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Cordia alliodora (Boraginaceae) as a candidate for tree plantations in French Guiana: characteristics and development of natural populations in Saül vicinity

JULIE BOSSU[1], PATRICK HEURET[2], HÉLÈNE MOREL[3], ERIC NICOLINI[3]
[1]CNRS, UMR Ecofog, 97387, Kourou, French Guiana
[2]INRA, UMR Ecofog, 97387, Kourou, French Guiana
[3]CIRAD, UMR Ecofog, 97387, Kourou, French Guiana

In French Guiana, forest accounts for almost 96% of the territory, with the habitat maintaining a good state of conservation. Nonetheless, forest management in this region faces new challenging issues given the emerging and increasing demands for wood products. The present-day challenge is to develop sustainable and efficient wood production solutions, whilst preventing deforestation and reducing the current dependence on importation. Plantations of native fast-growing species here represent a real potential. Cordia alliodora is a long-lived pioneer species known only in French Guiana in the vincinity of the town of Saül. This species appears to match the requirements for plantation growth, in relation to its very high growth rate and good wood properties. Nevertheless, to our knowledge, no growth monitoring has been conducted in French Guiana, with little information on the performance of local populations under natural conditions. Here, we present a retrospective analysis of C. alliodora development (primary and secondary growth) based on anatomical and morphological markers. To achieve this work, we also describe the past development of adjacent trees belonging to the pioneer species C. obtusa. This last species was considered here as "standard" to (i) estimate the age of secondary forest within which both species belong, (ii) demonstrate the annual nature of growth rings in C. alliodora and (iii) compare the growth trajectories of the two species. We sampled 13 and 15 individuals of C. alliodora and C. obtusa trees respectively in three contrasted sites in the region of Saül. Above 10 meters in height, which is the flowering stage of C. obtusa, our results show that C. obtusa and C. alliodora have a competitive growth in height despite two contrasted growth strategies (continuous growth vs. polycyclic rhythmic growth). Beyond this point, C. alliodora becomes dominant in the stand. Strong differences were observed in C. alliodora growth trajectory depending on the studied site, demonstrating a high phenotypic plasticity (lato sensu). We also estimate that under good growth conditions, this species is able to reach a productivity of 11 m3/ha/years and enable rotations in less than 30 years. From these promising results we can consider that C. alliodora is a good contender as an alternative timber productive system in French Guiana, provided it is accompanied by other species, such as C. obtusa, to encourage straight and rapid growth without bole defects.

O9-07 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Retrospective analysis of plant architecture: an extended definition of dendrochronology

PATRICK HEURET[1], YVES CARAGLIO[2], SYLVIE SABATIER[2], DANIEL BARTHÉLÉMY[2], ERIC NICOLINI[3]
[1]INRA, UMR ECOFOG, KOUROU, French Guiana
[2]CIRAD, UMR AMAP, MONTPELLIER, France
[3]CIRAD, UMR AMAP, KOUROU, French Guiana

Accurate expertise on plant development in space and time is fundamental to underpin conservation and management practices. Considering that trees are long-life organisms with a complex structure, understanding the rules of tree development, from seedlings to adult trees and for a given environment, is a steep task. Compared to field monitoring, retrospective analysis of plant incremental development (RAPID), based on the observation of morpho-anatomical markers allows accessing the past dynamics of plant architecture on many varied plants. However, it is clear that besides this very general approach, works based on axis thickening (mainly trunk) and growth rings structure (GR) remain a broad majority and they are recognized as a full-fledged discipline called dendrochronology. Etymologically, dendrochronology is the science (-logia) of reading the time (khronos) in trees (dendron). Nevertheless, it is clear that this definition applies equally to the crown expansion and to the understanding of the primary growth, branching or flowering processes through the study of morphological or macro-anatomical markers. Moreover, it is important to note that theses approaches can be applied not only in trees, but also in perennial herbaceous herbs or mosses that conduce some authors to propose the term herbchronology. Without trying to change the term of dendrochronology, etymologically limited, but widely used and deeply rooted in the scientific landscape, we support the idea that it should be extended to all approaches concerning the RAPID. In this presentation, we'll depict a summary of methods that allow accessing the past development of plants considering four major processes, growth I and II, branching, and flowering whatever the biological life-form. We'll discuss the close connection amongst the nature of theses processes, their phenology and the resulting morpho-anatomical structure. Considering that plant form integrates multiple environmental factors but, also, internal trade-offs among functions, we argue that integrative studies considering jointly morpho-anatomical markers in a RAPID approach offers powerful insights for diverse fields including plant biology, ecology, conservation.

O9-08 – S9 *Retrospective analysis of the growth of trees from their anatomy and morphology (ragtag)*
Monday 20 June 20 / 11:00-15:30 – Antigone3

Cambial activity of selected tropical trees in relation to different stem sizes and climatic factors growing in Malaysian rain forest

KANG HAN WANG, MOHD ZAKI HAMZAH, MOHD NAZRE SALEH, RASMINA HALIS
Universiti Putra Malaysia, Forest Production, 43400, Serdang, Malaysia

Majority of previous studies on cambial activity are conducted using temperate trees and tropical trees growing in distinct dry and wet season. Similar studies on the activity of vascular cambium are relatively few for trees growing in tropical rain forest with a lack of clear seasonality. Relationship between tree diameter growth and climatic factors has been extensively studied through dendrochronological research which generally detects tree growth by minimising tree characteristics and assuming that climate-growth relationship is independent of tree size. Nevertheless, recent studies have proven that the sensitivity of tree growth rate to climatic factors is dependent on both tree species and size. Therefore, the present study focused on investigating seasonal cambial activity in selected tropical tree species growing under natural conditions with different stem diameters. The objectives of this study were to: (1) record annual cambial growth dynamics in tropical trees with variation in tree sizes and species, and (2) determine the influence of climatic factors (rainfall, temperature, relative humidity and vapour pressure deficit) on cambial activity of tropical trees with different life forms. Macaranga gigantea, Shorea leprosula, Shorea acuminata and Shorea parvifolia growing in lowland dipterocarp rainforest of west Peninsular Malaysia were selected for this study. Wood blocks consisting inner bark, cambium and outer sapwood were collected from the main trunks of the living trees. Sections were cut from epoxy-embedded wood block using sliding microtome. The anatomical characteristics of the cambial activity were determined by counting the number of cambial and enlarging zone cells. The cambial activity of the examined species is shown to have active and inactive growth periods. Climatic factors affect the cambial activity of tree differently, depending on the tree species and stem size within the species. Rainfall did not play an important role in determining tropical rainforest tree growth, except for S. parvifolia with larger stem size. Atmospheric water status such as vapour pressure deficit and relative humidity seem to affect more on tree growth in S. parvifolia and S. acuminata with larger stem sizes. This is believed to be different from other tropical trees growing in tropical seasonal forests with distinctive dry and wet seasons, where rainfall plays a significant role in tree growth.

O10-01 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

Can wood collections contribute to the understanding of ecosystem dynamics? Updating a century old xylarium.

HANS BEECKMAN, NILS BOURLAND, VICTOR DEKLERCK, CLAIRE DELVAUX, MAAIKE DE RIDDER, THOMAS EL BERKANI, WANNES HUBAU, JULIE MORIN-RIVAT, MÉLISSA ROUSSEAU, YEGOR TARELKIN, SAM VAN HOLSBEECK
Royal Museum for Central-Africa, Wood Biology, 3080, Tervuren, Belgium

Wood science finds its classical justification in the prominence of lignified plant tissues in both living nature and material culture. Research on wood supports as well technological investigations as botanical disciplines like taxonomy and physiology. There is an additional and strongly growing interest that is driven by the commonly accepted understanding that forests are crucial to assure ecological functions and services and this at different geographic scales. Locally, forests provide resources for the economy in a potentially sustainable way and assure environmental protection. Globally, they play a key role in the climate regulation of the planet. Forests are therefore a major issue for nowadays international debates and policy.
The major part of the energy in forests is stockpiled in organic molecules and woody biomass in particular. It seems to be evident that the study of the fitness of small and large biotic systems could profit from research methodology that has been developed in wood science and wood anatomy in particular.
The question arises which traits can be read from xylarium specimens and how wood collections could be extended to underpin ecosystem modelling, given the fact that reference collections have been established mainly for taxonomy.
We analysed microscopically historical wood samples from two Biosphere Reserves in the rainforest of the Democratic Republic of the Congo.
We studied the variation of the density among the selected samples. We verified the tree-ring distinctness and compared this with available phenological information.
We discuss upscaling issues, standardizing for tree size, the relevance of juvenile and root traits, and opportunities to construct time axes.
We argue that collections of wood samples are valuable sources of information on tree performance and we suggest sampling strategies aiming at enrichment of the trait information content of xylariums.

O10-02 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

"To wake a sleeping beauty": the classification and scientific potential of the tropical wood collections at the Natural History Museum in Paris

BENOÎT CARRÉ1, MARGARETA TENGBERG[1], THIERRY DEROIN[2]
[1]UMR 7209 Archéozoologie, archéobotanique : Sociétés, pratiques et environnements (CNRS, Muséum national d'Histoire naturelle, Sorbonne Universités)
[2]UMR 7205 Institut de systématique, évolution, biodiversité, (CNRS, Muséum national d'Histoire naturelle, Université Pierre et Marie Curie, École pratique des hautes études, Sorbonne Universités)

The thorough renovation of the botanical gallery and the herbarium collections of the national Natural History Museum (Muséum national d'Histoire naturelle) in Paris, completed in 2013, has allowed the gathering of several wood collections in one single space and the creation of a true "xylothèque" containing more than 12,000 specimens.
The proposed oral presentation, within the session "Sleeping tropical beauties », will first describe the nature of the Paris wood collection with a special focus on tropical woods and then discuss the potential of these collections for scientific research.
The Xylothèque contains wood samples of various formats and sizes: small book-shaped blocks, discs, cubes, branches and trunk pieces as well as root and fibre collections. The specimens come from all over the world with Brazil, Madagascar, Australia, India, the United States and France being the best represented of the almost 80 countries inventoried. From a taxonomic point of view, 220 botanical families (on a total 413 ligneous families) have been listed, with most taxa coming from the tropical and subtropical regions. Many wood samples were brought back from field gathering expeditions from the early 19th century on, sometimes involving well-known plant collectors such as Humboldt and Bonpland, Claussen, Poilane and Chevalier. The wood samples were often collected at the same time as herbarium specimens allowing a taxonomic updating of the former. The collection also contains a fair number of nomenclatural types. Other samples have been acquired through exchanges with forestry departments and research institutions all over the world.
Besides being of major historic and heritage value, the Paris wood collections have a great potential as a tool for research, expertise and teaching. The gathered specimens can for example be the subject of studies in systematics, ecology and material sciences as well as serve as a referential for identification and research in fields such as palaeoecology, palaeobotany, archaeobotany and ethnobotany. The Xylothèque is associated with a wood laboratory, equipped with microscopes and an image analysis system that allows the direct study and documentation of wood specimens. A slide collection kept within the anatomical collection (Histothèque végétale) in the Herbarium completes the picture. The latter hosts for example the well-documented collection of around 500 slides referring to the woods of French Guyana (collection of Raymond B).

O10-03 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

Methodology to use Xylarium specimens to generate wood technological output

VICTOR DEKLERCK[1], JAN VAN DEN BULCKE[1], MAAIKE DE RIDDER[2], HANS BEECKMAN[2], JORIS VAN ACKER[1]
[1]Ghent University, Department of Forest and Water Management - Laboratory of Wood Technology, 9000, Ghent, Belgium
[2]Royal Museum for Central Africa, Service for Wood Biology, 3080, Tervuren, Belgium

Background: The Royal Museum for Central Africa in Tervuren (Belgium) houses the largest wood collection on Central African species worldwide. The Tervuren Xylarium is a 'sleeping beauty' because a considerable amount of valuable data is implicitly present in the specimens but not exploited. We are developing protocols to maximize the valorisation of the Xylarium in the framework of wood technological properties and appropriate wood use. This is part of the HERBAXYLAREDD-project that aims to renew, complement and strengthen the reference value of both the national Xylarium and Herbarium (Botanical Garden Meise) by generating knowledge, through analysis of specimens' traits and meta-data, on Central African forest ecosystems and forest products.
Method: Xylarium specimens are selected to assess wood density, durability, dimensional stability and aesthetical characteristics like wood colour. Ideal samples for wood density measurements, in terms of commercial wood products, consist solely of heartwood. Specimen cut out for durability testing are intended to comply with the guidelines of the EN 350 standard (1994, currently being revised) and the specific test protocol to test the durability of wood against wood-destroying basidiomycetes as detailed in CEN/TS 15083-1 (2005). When focusing on the dimensional stability mainly cross sectional slices are considered suitable. Often, 5.0 x 5.0 x 0.5 cm dimensions are used but it is not possible to cut these from the wood collection specimens. The use of Xylarium specimens for wood property data-gathering presents several challenges with the most important ones the non-standardised, even random specimens' format and a variety of forms (branches, disks, planks…). Several innovative approaches are evaluated to construct a working methodology to measure the characteristics discussed above for those Xylarium specimens, taking into account their collection value and hence the focus on the non-destructive character of the measurements or minimal intrusive impact of taking subsamples.
Results: Preliminary protocols on how to handle Xylarium specimens for wood technology measurements and semi-automated measurement techniques to determine dimensional stability are developed and can be presented and illustrated with examples.
Conclusion: Protocols on how to handle Xylarium specimens for a variety of measurements allow us to maximize the information output from the Xylarium in terms of wood technology and wood use.

O10-04 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

Sleeping beauties are awakening: the story of the African herbarium of the Botanic Garden Meise, Belgium

STEVEN JANSSENS1, BRECHT VERSTRAETE[2], PETER HIETZ[3], DAKIS-YAOBA OUÉDRAOGO[4], ADELINE FAYOLLE[4], CLAIRE DELVAUX[5], HANS BEECKMAN[5], MAAIKE DE RIDDER[5], ANN BOGAERTS[1], SOFIE DE SMEDT[1], PIET STOFFELEN[1]
[1]Botanic Garden Meise, Spermatophytes, 1860, Meise, Belgium
[2]Natural History Museum Denmark, EvoGenomics, 1307, Copenhagen, Denmark
[3]University of Natural Resources and Life Science Vienna, Institute of Botany, 1180, Vienna, Austria
[4]Gembloux Agro-Bio Tech, Unité Gestion des Ressources forestières, 5030, Gemboux, Belgium
[5]Royal Museum of Central Africa, Wood Biology, 3080, Tervuren, Belgium

Background: Herbaria have a long history that traces back to the early 16th century. Initially, herbarium specimens were a tool to illustrate medical plants. Since the Renaissance, the practice of making herbaria was promulgated by the establishment of botanical gardens and universities throughout Europe. In the same period, new continents were explored and an overwhelming biodiversity was discovered. Today ca. 3.000 herbaria are registered in Index Herbariorum and contain over 350 million specimens. Herbaria cover a wide range of taxonomic lineages, from vascular plants to fungi, lichens, mosses, algae and myxomycetes. Even though the main objective of herbaria is to document, identify and describe diversity, it becomes clear nowadays that herbaria contain a huge potential for cutting edge research in different disciplines. Here, we demonstrate the potential of herbaria for studies in tropical biology and conservation.
Methods: The African Herbarium of Botanic Garden Meise contains over 1 million specimens and is the reference collection for the Congo Basin, i.e. ca. 500.000 specimens or over 80% of the collections ever made in the Congo Basin. Interestingly, many specimens are linked with other collections (e.g. wood samples, liquid collections, seedlings). Furthermore, the African Herbarium is intensively studied by taxonomists. Selected projects are discussed that provide a good view on the different potential uses including genetics, trait measurements, species distribution and phenology.
Results & Discussion: Based on the large amount of different studies in which herbarium samples from the Botanic Garden Meise are used, it is clear that the institute harbors a collection that can be used for a wide range of disciplines. For example, improved DNA isolation protocols allow to extract DNA from herbarium samples with an average success of 60% for non-alcohol dried specimens of 50 years old, and even older specimens (up to 100 years old) treated with mercury-chloride still have a success of 10%. In addition, the use of herbaria in comparative trait analyses provide us with a better understanding of past and present ecosystems of the Congo Basin. Moreover, comparative studies on leaf traits are supported by leaf isotope analyses and demonstrate the importance of herbaria to link the past with the future. Last but not least, herbaria are an important tool for the verification of field identifications which are often problematic in tropical regions.

O10-05 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

The reproductive phenology of central African tree species: combining field observations and herbarium records

DAKIS-YAOBA OUÉDRAOGO[1], PIET STOFFELEN[2], JEAN-LOUIS DOUCET[1], KASSO DAÏNOU[3]
HANS BEECKMAN4, ADELINE FAYOLLE[1]
[1]University of Liège -- Gembloux Agro-Bio Tech, BIOSE -- Management of Forest Resources -- Tropical Forestry, 5030, Gembloux, Belgique
[2]Botanic Garden Meise, Herbarium of Vascular Plants, 1860, Meise, Belgique
[3]Nature+, Sylviculture, 1301, Wavre, Belgique
[4]Royal Museum for Central Africa, Wood biology, 3080, Tervuren, Belgique

Background: Reproductive phenology, the timing of flowering and fruiting events, is a key determinant of reproductive success in plant species. Phenology is also reported to be among the plant traits that are the most affected by the ongoing climatic change, but this issue remains poorly explored in African moist forests. In this study, we used herbarium specimens to investigate the reproductive phenology of major central African tree species over a continental scale, covering almost the whole species range.
Method: First, we defined homogeneous climatic regions and tested whether species had significant periodicity in their reproductive phenology using different approaches (graphical methods, Fourier spectral analysis, and circular statistics). Then, for the species displaying annual reproduction, we tested for significant differences in reproductive phenology between climatic regions, and discussed the strength of the climatic control. Finally, we used monthly phenological field surveys conducted in five sites distributed over Cameroon (n=2), Central African Republic (n=1), Congo (n=1), and Democratic Republic of the Congo (n=1) to validate the patterns inferred from herbarium specimens.
Results: We evidenced contrasted phenological patterns among the study species, from annual and highly seasonal pattern (e.g. Entandrophragma cylindricum, Milicia excelsa) to supra-annual reproductive phenology (Triplochiton scleroxylon). We identified a strong climatic control of annual patterns of reproductive phenology in accordance with the seasonal functioning of central African forests detected with remote sensing. We moreover demonstrated that the phenological patterns inferred from herbarium are consistent with those inferred from field surveys.
Conclusion: This study reinforced the high potential of herbarium data to study plant reproductive phenology, especially for tropical regions where intensive field surveys are lacking for a lot of species.

O10-06 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
Monday 20 June 20 / 16:00-17:30 – Antigone3

Two decades of historical phenology observations of African tropical tree species: exploring the past to predict the future

KOEN HUFKENS[1], MARGARET KOSMALA[1], ELIZABETH E. KEARSLEY[2], CORNEILLE E. N. EWANGO[3],
HANS BEECKMAN[4], HANS VERBEECK[2], ANDREW D. RICHARDSON[1]
[1]Harvard University, Department of Organismic and Evolutionary Biology, 02138, Cambridge, USA
[2]Ghent University, Department of Applied Ecology and Environmental Biology, 9000, Gent, Belgium
[3]Wageningen University, Department of Environmental Sciences, 6708, Wageningen, Netherlands
[4]Royal Museum for Central Africa, Laboratory of Wood Biology and Xylarium, 3080, Tervuren, Belgium

African tropical forests cover ~630 million ha, store up to 66 Pg of carbon and represent a significant carbon sink (0.34Pg C yr-1). As such African tropical forests provide an important negative feedback to the global carbon cycle. Unlike temperate forests, tropical forests lack sharp temperature and photoperiod cues to constrain phenology and growth. Therefore, events such as seasonal leaf abscission and reproductive life cycles are often driven by changes in water availability. With future climate predictions expecting a warmer, and especially drier tropical Africa, it is likely we will see concomitant changes in tree growth and phenology.
As tropical trees show a high degree of phenological plasticity depending on the severity of the dry season, intermittent water stress or the location of an individual in the canopy structure. As such, frequent and long term observations are key to characterize tropical tree phenology. Here I use two long term historical phenology records of weekly observations, some digitized within the context of a citizen science project (http://junglerhythms.org/), to explore differences in tree phenology between two sites (Luki and Yangambi, DR Congo) with contrasting climate regimes within the Congo basin. I describe variation in leaf, flower and fruit phenology across similar species at both locations in relation to complementary historical climatological observations. I further discuss the potential implications of changing phenology under future climate conditions as phenological changes could alter both ecosystem demography and growing season length providing important feedbacks to the climate system.

O11Part1-01 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Drought survival strategies of tropical trees

LOUIS SANTIAGO[1], DAMIEN BONAL[2], MARK DE GUZMAN[1], CLÉMENT STAHL[3], ELEINIS ÁVILA-LOVERA[1]
[1]University of California, Botany & Plant Sciences, 92521, Riverside, USA
[2]INRA, UMR EEF, 54280, Champenoux, France
[3]INRA, UMR Ecologie des Forêts de Guyane, 97379, Kourou, France

Background: Climate change is predicted to increase the occurrence of extreme droughts, which are associated with elevated mortality rates in tropical trees. Yet there is a surprising lack of predictive power for estimating which species will suffer the most mortality, due to the diversity of tropical trees and lack of knowledge of mortality mechanisms.
Method: We propose a conceptual framework that can be used to predict drought responses in tropical trees based on the traits that plants use to survive drought: 1) xylem that is resistant to drought-induced cavitation, 2) high sapwood capacitance that protects xylem from critically low water potentials, 3) drought deciduousness, 4) photosynthetic stems that have the potential to assimilate carbon at greater water-use efficiency than leaves, 5) deep roots, 6) regulation of gas exchange to reduce leaf water loss or to maintain photosynthesis at low leaf water potential and 7) when all else fails, low cuticular conductance from exposed tissues during extended drought.
Results: We present data on the occurrence of each of these traits in canopy tree species from Paracou, French Guiana to examine the distribution of drought survival strategies at this Amazonian Forest site. Xylem cavitation resistance and capacitance showed a narrow range among species. There were few species with photosynthetic stems or deciduousness. There was large variation in rooting depth and regulation of gas exchange. Cuticular conductance showed large variation, but there is little data in the literature for comparison.
Conclusions: To date, most research has focused on deciduousness, resistant xylem, soil water, gas exchange behavior and sapwood capacitance, whereas little is known about the role of photosynthetic stems or cuticular conductance during extreme extended drought, making these processes a high priority for a complete understanding of tropical tree physiology during drought. Our data indicate that drought survival strategies, similar to other ecological strategies, consist of the presence or absence of drought survival traits within species and coalesce around particular trait combinations.

O11Part1-02 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Physiological significance of hydraulic segmentation, nocturnal transpiration and capacitance: paradigms revisited

SANDRA BUCCI[1], GUILLERMO GOLDSTEIN[2], FABIAN SCHOLZ[1], FREDERICK MEINZER[3]
[1]Universidad Nacional de la Patagonia SJB and CONICET, Biology, 9000, Comodoro Rivadavia, Argentina
[2]Universidad de Buenos Aires and CONICET, Ecology, Genetic and Evolution, 1425, Buenos Aires, Argentina
[3]USDA Forest Service, Forestry Sciences Laboratory, 97331, Corvallis, USA

Background: Natural selection operates differently in the tropics and temperate zones causing tropical trees to be subjected to unique selective pressures during the evolutionary process. This resulted in a large array of life history traits and in particular a large array of functional traits related to the water relations of trees from tropical ecosystems. We explore the validity of some paradigms related to the (i) physiological significance of hydraulic segmentation across trees with different life history traits and habitats, (ii) determinants of massive tree mortality, (iii) nocturnal transpiration, and (iv) the role of internal stem water storage, which are currently being debated.
Materials and methods: we reanalyzed results from water relations and hydraulic architecture studies of trees from tropical savannas and humid tropical and subtropical forests.
Results and discussion: the degree of hydraulic segmentation varied among tropical trees, which was related to differences in life history traits (deciduous vs. evergreen) and to environmental characteristics where the trees occur (with vs. without a pronounced dry season). Evergreen tropical species and species growing in tropical ecosystems that experience seasonal droughts have leaves that are more vulnerable to drought induced cavitation compared to stems. Strong segmentation, and thus a decrease in total leaf area per plant during droughts help to maintain an adequate water balance, but incur in a large physiological cost: trees receive a lower return in carbon gain from their investment in aerial biomass. Thus, these two mechanisms, leaf hydraulic failure and carbon starvation, may contribute to massive, size-dependent mortality observed in same tropical species. Nocturnal transpiration resulted to be a widespread phenomenon in tropical trees and one of the most likely functions in trees growing in nutrient poor soils appears to be enhanced nutrient acquisition. Tropical trees have large sapwood capacitance which plays a central role in the growth patterns of deciduous species facilitating rapid canopy access as these species are less shade tolerant than evergreen species. Higher growth rates in species with high capacitance could be achieved by keeping the stomata open for longer periods of time. These aspects of tree hydraulic architecture and water transport are relevant for understanding potential woody species responses to global climate change and to land use changes.

O11Part1-03 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

The stable isotope fingerprint of Australian tropical rainforests

LUCAS CERNUSAK[1], RAYMOND DEMPSEY[1], JIMMY CHAMBI[2], HUGO NINANTAY[2], PAUL SANTOS[2], BRANDON MCNELLIS[3], LISA BENTLEY[4], YADVINDER MALHI[4]
[1]James Cook University, College of Marine and Environmental Sciences, 4878, Cairns, Australia
[2]Universidad Nacional de San Antonio Abad del Cusco, Departamento de Biologia, 08002, Cusco, Peru
[3]University of California Riverside, Department of Biology, 92507, Riverside, USA
[4]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, UK

Background: Tropical rainforests occur on only a small part of the Australian continent, mainly restricted to the Wet Tropics Bioregion, a humid tropical zone in northeastern Queensland. Tropical rainforest cover prior to European settlement was approximately 10,000 km^2. However, within this relatively small area, a broad range of climatic, topographic, and edaphic conditions exists. In order to gain insight into how these forests are likely to respond to climate change, we investigated functional traits of rainforest trees across an elevational gradient in the Wet Tropics Bioregion.
Method: We sampled the dominant tree species in eight permanent forest plots, ranging in elevation from 35 to 1544 m above sea level, in mean annual precipitation from1400 to >6000 mm, and in mean annual temperature from 17 to 26°C. We measured leaf gas exchange, nutrients, and stable isotope composition (carbon and nitrogen).
Result: At the plot level, leaf nitrogen concentration was higher for a plot on basaltic soils than in the remainder of plots, which were on granitic soils. For those on granitic soils, leaf nitrogen concentration decreased with increasing elevation and therefore with decreasing mean annual temperature. Across all plots, leaf nitrogen concentration was positively correlated with leaf delta 15N, suggesting a link between nitrogen availability and nitrogen cycle processes that control the isotopic composition of available nitrogen. Leaf carbon isotope discrimination was lowest in the plot with the lowest rainfall, and second lowest in the plot with the highest rainfall, indicating that different processes constrain the chloroplastic carbon dioxide concentration at either end of the rainfall gradient: a stomatal limitation at the dry end, and an internal conductance limitation at the wet end.
Conclusion: Functional traits, including stable isotope composition, provide a means of capturing the functional diversity of tropical rainforest trees. Incorporating these trait spectra into process-based models of ecosystem function should help to improve predictions of vegetation community responses to climate change in climatically and topographically diverse landscapes like those of the Wet Tropics Bioregion.

O11Part1-04 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Nutrient limitation in lowland tropical forests – lessons learned from fertilization experiments

EMMA SAYER[1], LINDSAY BANIN[2], LAETITIA BRECHET[3]
[1]University of Lancaster, Lancaster Environment Centre, LA1 4YQ, Lancaster, UK
[2]Centre for Ecology and Hydrology, Edinburgh, EH26 0QB, Edinburgh, UK
[3]Lancaster Environment Centre, Lancaster University, UK

Many highly productive tropical forests occur on nutrient-poor soils. Decades of research have focused on understanding which nutrients limit tropical tree growth - without reaching a general consensus. Fertilisation experiments are a useful approach for investigating nutrient limitation because we can measure changes in growth and productivity in response to the addition of specific nutrient elements. Unfortunately, the enormous diversity of tropical forest ecosystems often confounds attempts to measure a clear ecosystem response to fertilisation.
We reviewed a large body of experimental work in tropical forests to identify patterns in tree growth responses to nutrient amendments. We show how tree species' nutrient requirements can differ according to life history strategy, adaptation to site fertility, and the life stage of the individuals under study. We show numerous examples of how other limiting resources and species interactions can mask the effects of nutrient amendments. Finally, most fertilisation studies have investigated responses to nitrogen and phosphorus additions but there is increasing evidence that we need to consider how the balance of multiple macro- and micronutrients affects tropical forest growth and ecosystem dynamics. We conclude by discussing whether ecosystem responses to nutrient amendments are meaningful for highly diverse tropical forests and present important considerations for future experimental studies.

O11Part1-05 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Tapping another source: lianas' and trees' below ground competition for water

HANNES DE DEURWAERDER[1], PEDRO HERVÉ-FERNÁNDEZ[2], CLÉMENT STAHL[3], DAMIEN BONAL[4], BENOÎT BURBAN[6], PASCAL BOECKX[2], HANS VERBEECK[1]
[1]Ghent University, CAVElab Computational and Applied Vegetation Ecology, Department of Applied Ecology, 9000, Ghent, Belgium
[2]Ghent University, ISOFYS, Department of Applied analytical and physical chemistry, 9000, Ghent, Belgium
[3]University of Antwerp, Research Group of Plant and Vegetation Ecology (PLECO), 2610, Wilrijk, Belgium
[4]INRA, UMR EEF 1137, 54280, Champenoux, France
[5]INRA, UMR Ecologie des Forêts de Guyane, 97387, Kourou, French Guiana

Recent studies highlight distinct liana abundance and biomass increase in the neotropics in the last decades. The dominant underlying mechanism of this liana proliferation is currently unknown. However, several explanatory hypothesis have been proposed among which one ascribes lianas, in comparison to trees, being able to adapt better to increased drought conditions resulting from climate change. Moreover, lianas are indicated of having a deeper root system compared to tropical trees, providing access to deeper soil layers less susceptible for dehydration during drought events. This characteristics results in an increased belowground competitiveness for lianas. In order to test this hypothesis, water stable isotopes (2H and 18O) were measured in precipitation, bulk soil (at different depths), stream, and xylem water from lianas and trees. This was done in two catchments with different soil texture (sand and clay) in the close vicinity of the Guyana flux tower at Paracou (French Guyana) during October 2015. Our results show that in both catchments, lianas and trees use different sources of water, with lianas tapping water with a heavier isotope signature compared to those observed on tropical trees. Soil texture only affected tree water sources, with heavier isotopic xylem water found in trees growing in sandy soil.
Recent studies using water stable isotopes (2H and 18O) have described an ecohydrological separation of water between streams and the LMWL (i.e. soil mobile water) and plants (i.e. soil static water) indicated as the "two water world hypothesis", suggesting that vegetation is using water that is not contributing to stream water. Based on this concept, we further characterized all isotopic data by estimating the precipitation offset (Pp-offset) which represents the distance between the local meteoric water line (LMWL) and xylem 2H and 18O signature. Our results not only support this two-water-world hypothesis, but also show that lianas and trees on sand soils have very different Pp-offsets, where this difference were less distinct for clay soils. Thus suggesting that lianas and trees are using water with a different isotopic signature, therefore, distinct water sources.
In conclusion, our study shows that xylem water from lianas has a heavier isotopic signature than those observed in trees xylem water. Our results thus indicate that belowground competition for water between lianas and trees might be less strong than

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O11Part1-06 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Flood tolerant trees in seasonally inundated lowland tropical floodplains

PIA PAROLIN
INRA / UNIV. NICE SOPHIA ANTIPOLIS, M2P2, 06903, NICE / SOPHIA ANTIPOLIS, FRANCE

Trees are terrestrial organisms which need adaptations to cope with flooding. On every continent huge flood-pulsed tropical floodplains occur with a high species diversity. The regularity and predictability of the flood pulse allow for the development of adaptations. Depending on the conditions of flooding, environmental specificities and age of the ecosystem, different numbers of tree species are adapted. When roots are waterlogged, or when whole plants are submerged, species can display a range of responses. The degree of flood tolerance depends, in large part, on the time taken to colonize the floodplains. In this presentation, the diversity and responses of trees in four tropical floodplain ecosystems on different continents are outlined: the Pantanal in South America, the Okavango Delta in Africa, the Tonle Sap floodplain of the Mekong River in Asia, and the Australian "Wet-Dry Tropics" of the Northern Territory. One main result was that for many of the world's largest wetlands, only basic data on hydrology and climatology are available with almost no information on plant distribution, tree adaptations and ecophysiology. It is important to raise attention to such poorly researched wetlands which are often inaccessible for social and political reasons but which are threatened by the ever-increasing human population and its need for water, food, waterways and hydroelectric power. The destruction is so fast that we may never learn of the adaptations underpinning the success of the tree species in these areas. By comparing diversity and tree responses in four floodplain ecosystems on different continents, we attempt to improve our understanding of the factors influencing spatial distribution of plants, diversity of species and adaptations and thus contribute to our knowledge of tropical wetland ecology. In this way, we hope to assist in the successful restoration of degraded floodplains and promote the sustainable use and conservation of these highly valuable ecosystems. In the light of climatic changes, floodplains, which by their environmentally drastic conditions are very resilient, are likely to become even greater hotspots for biodiversity and very significant biological corridors. Where possible, future studies should adopt methods that will allow comparisons to be made with confidence. Improving our understanding of floodplain functioning will underpin their preservation and effective future management.

O11Part1-07 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Distribution and physiology of palms in response to global environmental change

HEIDI RENNINGER[1], NATHAN PHILLIPS[2]
[1]Mississippi State University, Forestry, 39762, Mississippi State, USA
[2]Boston University, Earth and Environment, 02215, Boston, USA

Background: Palms (Arecaceae) represent one of the oldest surviving monocot families maintaining a presence in tropical rainforest-like biomes throughout history. In the Amazon, they are second only to the Fabaceae in tree abundance making them a critical component in this and other tropical biomes. Despite this, physiological research on palms remains scarce and has been primarily focused on agriculturally important species including date palm, coconut palm and oil palm. Because palms differ from dicotyledonous trees in several key ways including their lack of dormancy mechanisms and a vascular cambium and their reliance on a single apical meristem complex for aboveground growth, they will likely differ in their response to global climate change compared with tropical dicot species.
Methods: We reviewed the existing literature on palm physiological ecology and biogeography in order to identify the environmental driving factors that are most important in determining palm responses to future climate change and how these responses may differ from tropical dicot trees. This information can also shed light on responses of palm crops to environmental change including changes in productivity and water use.
Results: Due to their lack of winter dormancy mechanisms, temperature increases have the potential to extend palm distributions to higher elevations and latitudes, but could negatively affect individual palm carbon balance because palms contain more living cells within their trunks compared to dicot trees. Within the tropics, precipitation has been shown to have the strongest positive effect on palm species richness with palm physiology showing strong water conservation responses to drought stress. Therefore, future changes in rainfall patterns will likely alter palm distributions and productivity regionally.
Discussion: Based on the physiological constraints of palms compared with dicot species as well as studies of palm distributions and species richness patterns at various scales, water availability and hydrologic factors are of critical importance in explaining current and future patterns of palm abundance and richness. Because palms play an important role in many tropical ecosystems providing a food source and habitat for a variety of species, their altered abundance in tropical ecosystems will have broad implications for ecosystem functioning and resiliency to climate change.

O11Part1-08 – S11 *Tropical tree physiology. Part 1. Adaptations and responses to changes in soil water availability tropical tree physiology*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Do photosynthetic stems have higher water use efficiency than leaves? Implications for drought responses of tropical and subtropical plants

ÁVILA-LOVERA ELEINIS[1], TEZARA WILMER[2], HERRERA ANA[2], EZCURRA EXEQUIEL[1], SANTIAGO LOUIS[1]
[1]University of California, Riverside, Botany and Plant Sciences, 92521, Riverside, USA
[2]Universidad Central de Venezuela, Centro de Botánica Tropical, Instituto de Biología Experimental, 1041-A, Caracas, Venezuela

Background: Plants with photosynthetic stems are frequent in tropical dry forests, tropical thorn scrubs and subtropical deserts. Recent studies discuss the advantages of having photosynthetic stems in these dry and warm ecosystems. These advantages include: 1) extra carbon gain during leafless periods, 2) higher photosynthetic water use efficiency (WUE, ratio of carbon gain to water loss) in stems than in leaves, and 3) reduction of carbon losses due to re-assimilation of respired carbon dioxide. There is support for the first and third advantages. However, no formal evidence exists for the second one. Reports of higher WUE in stems than leaves have been found in the literature, but they are usually based on gas exchange data of one or two species during a single year.
Methods: We assembled a database on photosynthetic rate, stomatal conductance, and carbon isotopic composition of leaves and photosynthetic stems of c. 28 species, including both published data and our own results. We also looked for traits that allowed us to compare leaves and stems in terms of their photosynthetic capacity and hydraulic performance.
Results: Although intrinsic WUE (photosynthetic rate/stomatal conductance) of stems was higher than of leaves most of the time, its high variance made this difference statistically nonsignificant. However, carbon isotopic composition of stem photosynthetic tissue was significantly higher than leaves across all species, indicating a higher long-term WUE in stems than leaves. We also found that photosynthetic capacity was higher for leaves than for stems, as shown by measures of maximum and relative quantum yield of photosystem II, and chlorophyll content. An evaluation of four species seems to yield a positive correlation between stem and leaf hydraulic conductance but more information is needed to draw a general pattern.
Conclusions: Stems have higher long-term water use efficiency than leaves, which enhance whole-plant WUE, and is beneficial for plants during drought when they are leafless. Although their capacity to assimilate carbon is less than that of leaves, this low but continued assimilation throughout the year makes stem photosynthesis a likely survival trait. More research is needed to study the possible coordination between leaf and stem hydraulic conductance, the role of stem cuticular conductance in water loss when plants experience extended drought, and their implications for plant drought responses in the tropics and subtropics.

O11Part2-01 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Facing shortage or excessive light: how tropical and subtropical trees adjust their photosynthetic behavior and life history traits to a dynamic forest environment

GUILLERMO GOLDSTEIN[1], LOUIS S. SANTIAGO[2], PAULA I. CAMPANELLO[3], GERARDO AVALOS[4], YONG-JIANG ZHANG[5], MARIANA VILLAGRA[3]
[1]Universidad de Buenos Aires, Ecología Genética y Evolucion, C1428EGA, Buenos Aires, Argentina
[2]University of California Riverside, Botany and Plant sciences, 33124, Riverside, USA
[3]Universidad Nacional de Misiones, Instituto de Biología Subtropical, N/A, Iguazú, Argentina
[4]Universidad de Costa Rica, Escuela de Biología, 11501-2060, San José, Costa Rica
[5]Harvard University, Organismic and Evolutionary Biology, 02138, Cambridge, USA

Light is critical for plant establishment, growth, and survival in wet tropical and subtropical forests. We will analyze paradigms of photosynthetic performance and life history traits of tropical and subtropical forest trees in contrasting light environments of the forest floor, gaps and upper canopy. Physiological and morphological plasticity as well as genetically fixed adaptive traits will be discussed, including leaf optical properties and photoprotection from high irradiance. Photosynthetic adaptations to contrasting light environments of closely related species will be analyzed. This approach has the advantage among comparative studies of adaptations across species in that genetic relationships among species are known. Species specific variations in maximum photosynthetic rates, which reflect the degree of adaptation to growth irradiance, are shown to be gradual, suggesting that classification into two distinct functional groups in terms of light requirements is somewhat arbitrary. Trees growing in gaps or in the upper canopy rely strongly on biochemical mechanisms to dissipate excess energy and to avoid damage to the light reaction centers and photosystems. Consistent with their high photosynthetic capacity, light demanding species are capable of plastic changes in hydraulic architecture, such as increases in hydraulic conductivity under high irradiance, which makes them more competitive in open habitats.

O11Part2-02 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Functional diversification of Crassulacean Acid Metabolism in tropical epiphytic orchids

KATIA SILVERA[1], KLAUS WINTER[2], NORM ELLSTRAND[1], VICTOR ALBERT[3], JIM LEEBENS-MACK[4]
[1]University of California Riverside, Department of Botany and Plant Sciences, 92521, Riverside, California, United States
[2]Smithsonian Tropical Research Institute, Balboa, Ancon, Panama, Panama
[3]University of Buffalo, Department of Biological Sciences, 14260, Buffalo, New York, United States
[4]University of Georgia, Department of Plant Biology, 30602, Athens, Georgia, United States

Tropical epiphytes may be the most species-rich life form in wet rainforest sites. Many epiphytes utilize Crassulacean Acid Metabolism (CAM) as a water-conserving mode of photosynthesis, especially in the Bromeliaceae and Orchidaceae plant families. To investigate patterns of functional diversification related to the expression of CAM in orchids, we performed carbon isotope analysis of leaf samples from over 1,500 species, character state reconstruction and phylogenetic trait analysis of CAM and epiphytism, and showed that CAM has evolved more than once in orchid family. A large CAM radiation event was prominent within the Epidendroideae, which provided the majority of extant CAM species in the group. Measurements of 24 hour gas-exchange shows that some orchid species with weakly expressed CAM can significantly increase their CAM activity when water stressed and, in some cases, revert to weak CAM upon re-watering, suggesting that modulation of CAM may have also contributed to diversification within the Epidendroideae. Using the miniature orchid species Erycina pusilla (strong CAM) and Erycina crista-galli (C3 species) our team is discovering candidate CAM regulators and beginning to understand the molecular basis for the evolution of CAM in plants. This project is part of a Dimensions of Biodiversity team effort aimed at understanding the evolution of CAM in plants.

O11Part2-03 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Ecophysiology of leaf lifespan in tropical forests: adaptive and plastic responses to environmental heterogeneity

SABRINA E. RUSSO[1], KAORU KITAJIMA[2]
[1]University of Nebraska, Biological Sciences, 68588-0118, Lincoln, USA
[2]Kyoto University, Forest and Biomaterial Science, 606-8502, Kyoto, Japan

Background: Leaf lifespan, the time from leaf expansion to shedding, exhibits wide variation and is a key integrator of relationships with photosynthetic rate, leaf mass per area (LMA), and leaf nitrogen among coexisting tropical tree species. We present a hierarchical view of sources of variation in functional traits, including leaf lifespan, in tropical forests, emphasizing the importance of substantial within-species variation, which has rarely been addressed.
Methods: Using data from observational and experimental studies of leaf lifespan, LMA, lamina density, and leaf nitrogen, we examine inter and intraspecific variation in these traits with respect to light and soil resource availability in Bornean and Panamanian tropical tree species.
Results: Interspecific variation in leaf lifespan was positively correlated with LMA, varying from short-lived, low-LMA leaves to long-lived, high-LMA leaves of species associated with resource-rich versus resource-depleted habitats, respectively. Phenotypic responses of leaf lifespan and LMA to light show counter-gradient variation: with acclimation to shade, leaf lifespan increased, and LMA decreases, but both increased with adaptation to shade. In contrast, phenotypic responses to soil fertility showed co-gradient variation: both leaf lifespan and LMA increase with declining fertility both inter- and intraspecifically, but the interactive effects of light and soil resources can produce complex phenotypic responses. The magnitude of within species variation in LMA was correlated with that for leaf lifespan, but depended upon the mean values of the traits. Along the same resource gradients, at longer lifespans, proportionally greater plasticity was exhibited in lifespan than in LMA, whereas the reverse was true at shorter lifespans.
Discussion: Many factors govern the magnitude of intraspecific variation in leaf functional traits: plasticity varies among traits and depends on the type of environmental factor being varied, as well as mean trait values. Future studies of leaf lifespan should devote more attention to within-species variation to better quantify and explain how leaf lifespan is central to trade-offs generating the contrasting ecological strategies of tropical tree species.

O11Part2-04 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Drought resistance of tropical relict species in subtropical arid shrublands of southern California

MICHAEL TORRES, ELEINIS AVILA-LOVERA, MARK DE GUZMAN, LUIS TORRES, LOUIS SANTIAGO
University of Califonia, Botany and Plant Sciences, 92521, Riverside, USA

Background: The California Floristic Province is comprised of species originating from tropical floras to the south, desert floras to the east, and coniferous forests to the north. However, with the development of a Mediterranean-type climate with cool wet winters and hot dry summers approximately 3 million years ago, many species have gone locally extinct due to lack of resistance to the change in environmental conditions. Species that remain represent groups selected from a larger pool of species adapted to the summer rainfall climate present before the Pliocene throughout western North America. However, whether biogeographical origin affects the ability of species to respond to further changes in climate, such as drought or increasing temperature, is unknown.
Method: We investigated whether species of tropical origin differ in their drought resistance characteristics compared to co-occurring species derived from temperate desert ancestors. We measured seven drought survival traits that characterize how species respond to and possibly survive drought to better understand the effects of biogeographical origin on drought resistance in current mixed plant communities.
Result: The two species of tropical origin, Rhus ovata (Anacardiaceae) and Senegalia gregii (Fabaceae) showed a more vulnerable xylem than other species and differences in hydraulic architecture and leaf traits that may correspond to their tropical origin.
Conclusion: Due to the seasonal rain that the chaparral biome receives, this research examines the characteristics that have developed which enable the plant species to resist drought, and how these traits differ from plant species of temperate origin. In times of severe environmental conditions, such as the pervasive California drought, it is important to recognize how these plant species react to rapid climate change in order to improve predictions of climate change outcomes and to better preserve native plant species.

O11Part2-05 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Dependence of P-limited tropical rainforest trees on different soil organic P fractions as a P source inferred from an NP fertilization experiment in Borneo

DAIKI YOKOYAMA[1], NOBUO IMAI[2], KANEHIRO KITAYAMA[1]
[1]Kyoto University, Graduate school of Agriculture, 6068502, Kyoto, Japan
[2]Kyoto University, Primate Research Institute, 4848506, Inuyama, Japan

Phosphorus (P) is widely considered to constrain productivity in tropical rainforests. It is well known that P-limited trees produce higher amounts of root phosphatase to mineralize soil organic P. Soil organic P occurs as various chemical forms (i.e. mainly monoester-P, diester-P, pyrophosphate, phytate), which differ completely in biological availability from each other. Each organic P is mineralized by a different type of phosphatase (i.e. phosphomonoesterase, PME; phosphodiesterase, PDE; pyrophosphatase, PyP; and phytase, PhT, respectively). Since previous studies studied primarily PME and/or PDE, it is unknown which soil organic P forms are preferentially utilized by trees adapted to P deficient environments.
We measured four types of phosphatase activity (PME, PDE, PyP, and PhT) of fine roots in NP fertilized Bornean tropical rainforests, Sabah, Malaysia. These plots were established in December 2011 in primary and secondary forests with three replicates of four fertilization treatments (control, +N, +P, +NP). It is well known that removal of P limitation by P fertilization decreases root PME activities, indicating that P limitation enhances the acquisition of P from soil organic P. We investigated which soil organic P was preferentially utilized by P-limited trees by comparing responses of the four types of phosphatase to P (N) fertilization. We also investigated whether such a preference varied depending on successional stages which reflected life history strategies of trees.
We performed a three-way ANOVA to analyze the effects of forest type, +N and +P on each phosphatase. We found significant effect of forest type and +P on fine root PME, PyP and PhT. P fertilization decreased activities of fine root PME, PyP and PhT. Mean PME and PyP activities were higher in primary forests whereas PhT activities were higher in secondary forests.
These results show that P-limited trees enhance the acquisition of P from soil monoester P, pyrophosphate and phytate as a P source, indicating that P-limited trees prefer organic P that can directly release inorganic P by one step of enzymatic reaction. These chemical forms are mineralized by PME, PyP and PhT respectively, whereas diester-P is mineralized by two steps successively with PDE and PME. We also suggest that trees in secondary forests are more dependent on recalcitrant phytate, which may reflect that higher N-resource pioneer species can produce more costly PhT.

O11Part2-06 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Tuesday 21 June / 10:00-12:00 – Rondelet

Nutrient availability in tropical rain forests: the paradigm of phosphorus limitation

JAMES DALLING[1], CAMILO ZALAMEA[2], CAROLINA SARMIENTO[2], KATHERINE HEINEMAN[1], OMAR LOPEZ[2], JOSEPH WRIGHT[2], BENJAMIN TURNER[2]
[1]University of Illinois, Plant Biology, 61801, Urbana, USA
[2]Smithsonian Tropical Research Institute, 0843-03092, Panama City, Panama

A long-standing paradigm in tropical ecology is that phosphorus (P) availability limits the productivity of most lowland forests, with the largest pool of plant-available P resident in biomass. Evidence that P limits components of productivity is particularly strong for sites in Panama and the Amazon basin. Analyses of forest communities in Panama also show that tree species distributions are strongly affected by P availability at the regional scale, but that their local distributions in a single site on Barro Colorado Island (BCI) are as frequently correlated with base cations as with P. Traits associated with species sensitivity to P availability require more detailed exploration, but appear to show little similarity with those associated with N limitation in temperate forests. Recent research indicates that a large fraction of P in tropical forests exists as organic and microbial P in the soil; plant adaptations to access organic P, including the synthesis of phosphatase enzymes, likely represent critical adaptations to low P environments. Plants also cope with low P availability through increases in P use-efficiency resulting from increased retention time of P in biomass and decreased tissue P concentration. Although foliar P responds strongly to P addition, we show here that foliar P and N:P are highly variable within communities, and at BCI correlate with regional species distributional affinity for P. An improved understanding of P limitation, and in particular the plasticity of responses to P availability, will be critical to predicting community and ecosystem responses of tropical forests to climate change.

O11Part2-07 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Leaf traits and environmental factors: Searching for relationships for tropical forests and savannas

TOMAS DOMINGUES[1], TED FELDPAUSCH[2], GUSTAVO SAIZ[3], FRAZISKA SHRODT[4], FRANÇOISE ISHIDA[5], GABRIELA NARDOTO[6], PATRICK MEIR[7], JOHN GRACE[8], JAMES RATTER[9], JONATHAN LLOYD[10]
[1]University of São Paulo, Biology, 14040-901, Ribeirão Preto, Brazil
[2]University of Exeter, Geography, EX4 4RJ, Exeter, UK
[3]IMK-IFU, Bio-Geo-Chemical Processes, 82467, Garmisch-Partenkirchen, Germany
[4]Max Planck Institute for Biogeochemistry, Department Biogeochemical Integration, 07745, Jena, Germany
[5]James Cook University, School of Marine and Tropical Biology and Centre for Tropical Environmental and Sustainability Science, 6811, Cairns, Australia
[6]University of Brasilia, Ecology, 70910900, Brazilia, Brazil
[7]Australian national University, Biology, 2601, Canberra, Australia
[8]University of Edinburgh, School of GeoSciences, EH9 3FE, Edinburgh, UK
[9]The Royal Botanic Garden Edinburgh, Tropical Section, EH3 5LR, Edinburgh, UK
[10]Imperial College Of London, Department of Life Sciences, SW7 2AZ, London, UK

Forests and savannas, given its extension and biomass, are two important features of the tropical landscape. The current distribution of these formations is often a topic of debated in the literature. Currently, studies are focusing on how functional diversity can be used to mechanistically explain the functioning of such ecosystems, and therefore, the observed spatial distribution. Here we present an evaluation of leaf functional traits from 60 research sites comprising high biomass forests to low biomass savannas, from South America, Africa and Australia. As functional traits, we evaluate leaf photosynthetic capacity, nitrogen and phosphorus content and mass to area ratio. The variability of those traits are evaluated regarding site-specific environmental variables related to soil (nutrient availability, clay/sand/silt content), climate (dry season length, potential evapotranspiration, mean temperature, etc) and community parameters (basal area, canopy height, species diversity). Results indicate weak relationships among parameters, therefore suggesting a general lack of deterministic relationships between leaf traits and environmental drivers. Previous studies encompassing broad vegetation categories, including temperate vegetation has suggested a coupling of leaf traits and soil or climate parameters, but apparently, such relationships are less prominent on more limited spatial scales, interestingly more so for tropical systems. One possible reason for tropical vegetation to exhibit loose relationships is the usual high diversity of phylogenetic lineages.

O11Part2-08 – S11 *Tropical tree physiology. Part 2. Adaptations and responses to changes in nutrient and light resources*
Monday 20 June 20 / 11:00-15:30 – Rondelet

Hydraulic strategies of vessel occluding plants in lowland tropical forest

MARK DE GUZMAN[1], LOUIS SANTIAGO[1], DAMIEN BONAL[2], CHRISTOPHER BARALOTO[3], CLAIRE FORTUNEL[4], JACOB VOGENBERG[1], MAX BRODIE[1]
[1]University of California Riverside, Botany and Plant Sciences, 92521, Riverside, USA
[2]Université de Lorraine, Forest Ecology and Ecophysiology, 54280, Champenoux, France
[3]Florida International University, Biological Sciences, 33199, Miami, USA
[4]University of California Los Angeles, Ecology and Evolutionary Biology, 90095, Los Angeles, USA

Background: Large-scale forest dieback associated with global-change-type drought is reported throughout the world, and is expected to increase with predicted climate scenarios. The processes leading to drought-induced mortality of tropical trees, and the relevant traits associated with differential drought susceptibility remain poorly understood. In fact, the largest uncertainties in simulating how tropical forest carbon stocks might alter in response to climate change are associated with plant physiological responses. Thus, characterizing the physiological mechanism of plant response to drought is of critical importance.
Method: We investigated the hydraulic physiological response of plants that are able to modify the hydraulic transport capacity at various capacities in the form of vessel occlusion, which occurs when air-embolised vessels are filled with exudates such as tyloses, gels, or pectins, in the Amazonian rainforest at French Guiana. To test the hypothesis of vessel occlusion increasing drought resistance, we generated vulnerability curves that assessed the loss in conductive capacity of stems to transport water to leaves in response to declining xylem pressure. We also characterized water relation traits such as stem capacitance, gmin, and Ψmin, and also characterized traits that influence hydraulic architecture such as SLA, ρwood, dstem, and bark thickness.
Result: Our findings reveal that vessel occlusion influences the hydraulic transport of these plant species by reducing the overall stem conductive capacity and that vessel occlusion is a timed response to drought. Furthermore, vessel occlusion increases the resistance of the plants to drought by shifting the vulnerability curve towards more negative range of water potential. Across species, trade-off occurs between investment in wood structure and reliance on transient release of water in response to increasing water deficit.
Discussion/Conclusion: The influence of vessel occlusion on the drought resistance of plants has direct implications on how we characterize plant response to drought. To date characterization of drought response in the form of vulnerability curves does not directly identify a timed-response component and have solely been focused on plant strategic reliance on robust vessel structures. Thus, vessel occlusion may have implications for plant response to drought in terms of carbon and water balance.

O12-01 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

Morphological and genetic variation in native and introduced Clidemia hirta

DEWALT SAARA
Clemson University, Biological Sciences, 29634, Clemson, SC, USA

Background: The origin of exotic, invasive plants is often unknown but determining from what where in the native range a species originated is a necessary first step to be able to test hypotheses concerning invasiveness. In particular, areas of origin in the native range must be identified to be used in common garden or reciprocal transplant studies to evaluate whether post-introduction evolution has occurred that would contribute to invasiveness. Identifying areas of origin may also contribute to more efficacious biological control programs because pathogens and herbivores selected from those areas may have greater virulence or pathogenicity on invasive genotypes than ones selected from a different part of the native range. I asked from where in the native range of Central and South America and the Caribbean Islands do invasive populations of Clidemia hirta (Melastomataceae) originate. This shrub was accidentally introduced and is now invasive in continental areas of Asia, Africa, and Australia as well as numerous islands in the Indian and Pacific Oceans.
Methods: I compared genetic profiles and morphological characteristics of C. hirta collected from across its native and invasive ranges.
Results: Clidemia hirta was genetically variable across the native range at nine microsatellite loci and ETS sequences, but invasive range populations only had one of two multilocus genotypes. One multilocus genotype of Clidemia hirta sampled from southeastern Brazil (Paraná state) most closely matched the dominant invasive genotype. Northern South American genotypes from Venezuela were a genetic match for a less common invasive genotype found only in parts of Southeast Asia. Herbarium specimens of plants collected from across the native range showed little morphological variation, with trichome densities and leaf shapes of plants from Central and South America and the Caribbean Islands being statistically indistinguishable. Testing for morphological differences between native and invasive range specimens remains to be conducted.
Discussion: Southeastern Brazil and northern Venezuela have been identified as the two areas of origin for invasive Clidemia hirta. How these plants got to Java and Fiji in the late 1880s and then spread from there is still unknown. Nevertheless, now I can conduct experiments testing for that test whether post-introduction evolution has occurred and compare virulence and pathogenicity of pathogens from origin and non-origin areas.

O12-02 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

The effects of intra- and interspecific competition on mortality and growth of tropical tree seedlings

VALERIA FORNI MARTINS[1], RAFAEL CARVALHO DA COSTA[2], CAROLINA BERNUCCI VIRILLO[3], THORSTEN WIEGAND[4], FLAVIO ANTONIO MAES DOS SANTOS[5]
[1]Federal University of Sao Carlos - UFSCar, Natural Sciences, Maths and Education, 13600-970, Araras, Brazil
[2]Universidade Federal do Ceara - UFC, Departament of Biology, 60440-554, Fortaleza, Brazil
[3]Secretaria do Meio Ambiente do Estado de Sao Paulo, Coordenadoria de Biodiversidade e Recursos Naturais, 13100-111, Campinas, Brazil
[4]Centre for Environmental Research – UFZ, Department of Ecological Modelling, 04318, Leipzig, Germany
[5]University of Campinas - UNICAMP, Department of Plant Biology, 13083-970, Campinas, Brazil

Background: An important question in Ecology is how so many species can coexist in mega diverse regions, such as tropical forests. One of the main coexistence mechanisms is negative density dependence (NDD), especially at the seedling stage, due to Janzen-Connell effects and intraspecific competition. Most studies have focused on the former rather than the latter, even though they may contribute differently to coexistence. This is because competition not always leads to death as plants can compensate for the high density of neighbours with a plastic response involving decrease in growth rate and reproductive success. Additionally to resource sharing within seedlings, they may also compete with conspecific and heterospecific adults. Nevertheless, conspecific effects should be stronger as a requirement for NDD to promote diversity. Here we assess the effects of intra- and interspecific competition on mortality and growth of seedlings of five tree species of the Brazilian Atlantic Rainforest.
Method: We used modern spatial point pattern analysis with appropriate null models to assess density dependent mortality due to intraspecific competition within seedlings, the probability of seedling mortality near conspecific and heterospecific adults, the effects of intraspecific competition within seedlings on their size, and the effects of intra- and interspecific competition from adults on the size of seedlings.
Result: Only one species presented density dependent mortality due to intraspecific competition within seedlings. The probability of seedling mortality was random in relation to the distance from conspecific and heterospecific adults for all species. Three species, which do not include the one that showed density dependent mortality, presented decrease in growth at areas with high seedling density and near conspecific adults. Only one of them also presented decrease in growth near heterospecific adults.
Conclusion: Mortality due to intraspecific competition is not pervasive at the seedling stage as to promote coexistence through NDD. However, NDD is not restricted to seedlings and future studies should aim at integrating the lifetime effects of neighbours across all stages in order to assess the full scope of density dependent mortality in community assembly at the Brazilian Atlantic Rainforest. This study also shows that plants may respond differently to resource sharing, as some of the species studied presented decrease in growth rather than mortality.

O12-03 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

How do the photosynthetic capacity parameters Vcmax and Jmax vary along local nutrient availability gradients in the primary tropical rain forests in French Guiana?

LORE VERRYCKT[1], IFIGENIA URBINA[2], LEANDRO VAN LANGENHOVE[1], ROMÀ OGAYA[2], DANIEL GOLL[3], CLÉMENT STAHL[1], ELODIE COURTOIS[1], SARA VICCA[1], JOSEP PEÑUELAS[2], JÉRÔME CHAVE[4], IVAN JANSSENS[1]
[1]Univerrsity of Antwerp, Biology, 2610, Wilrijk, Belgium
[2]CREAF, Global Ecology Unit, 08193, Barcelona, Spain
[3]CEA-CNRS-UVSQ, LSCE, 91191, Gif-Sur-Yvette, France
[4]CNRS & Université Paul Sabatier, UMR 5174 Laboratoire Evolution et Diversité Biologique, 31062, Toulouse, France

Nutrient availability exerts a strong effect on photosynthetic C gain across the Amazon Basin. In tropical forests plants are often more limited by P than by N and since nutrient limitation is only recently being implemented into most global vegetation models, considerable uncertainties remain in these models. Most vegetation models represent the photosynthesis process according to the Farquhar-von Caemmerer-Berry model. This model simulates photosynthesis using meteorological data and the photosynthetic capacity of leaves, which is quantified by the maximum rate of Rubisco-catalysed carboxylation (Vcmax) and the maximum rate of electron transport (Jmax). Plant carboxylation rates are limited by one of these processes. The apparent dark respiration during the day light (Rd) is also a significant part of the carbon lost by plants. Since tropical forests account for one-third of global primary production, reliable estimates of these parameters (Vcmax, Jmax and Rd) are of major importance for global C cycle models. We conducted our fieldwork in French Guiana, a country dominated by tropical rainforest covering strong soil fertility gradients. We selected two forests sites covering a gradient of soil types, ranging from tropical white sands to peaty clay. At each of these sites, 12 50x50m plots were selected along a natural soil P availability gradient induced by local differences in topography. Photosynthesis was measured in a 20x20 m subplot within each 50x50 m plot to avoid edge-effects in a future fertilisation experiment (starting in autumn 2016). We measured A-Ci curves at two height levels in the canopy for 120 trees (5/plot), resulting in over 800 measurements in total. Here we will present the results of Vcmax, Jmax and Rd in relation to soil nitrogen and phosphorus availability as well as leaf stoichiometry and other leaf characteristics such as specific leaf area and CCM, a measure for chlorophyll.

O12-04 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

Plasticity in the water relations and anatomy of leaves of tropical rainforest trees in response to experimental drought

OLIVER BINKS[1], PATRICK MEIR[2], LUCY ROWLAND[9], ANTONIO CARLOS LOLA DA COSTA[3], STEEL SILVA VASCONCELOS[4], ALEX ANTONIO RIBEIRO DE OLIVEIRA[3], LEANDRO FERREIRA[5], BRADLEY CHRISTOFFERSEN[6], ANDREA NARDINI[7], MAURIZIO MENCUCCINI[8]
[1]University of Edinburgh, School of GeoSciences, EH9 3FE, Edinburgh, UK
[2]Australian National University, Research School of Biology, 2601, Canberra, Australia
[3]Universidade Federal do Pará, Centro de Geosciências, 66075-110, Belém, Brazil
[4]EMBRAPA, Amazônia Oriental, 66095-903, Belém, Brazil
[5]Museu Paraense, Emílio Goeldi, 66077-830, Belém, Brazil
[6]Los Alamos National Laboratory, Earth and Environmental Science, NM 87545, Los Alamos, USA
[7]Universitá di Trieste, Dipartimento di Scienze della Vita, 34127, Trieste, Italy
[8]ICREA, CREAF, 08193, Barcelona, Spain
[9]University of Exeter, College of Life and Environmental Sciences, EX4 4PY, Exeter, UK

The tropics are predicted to become warmer and drier, and understanding the sensitivity of tree species to drought is important for characterising the risk to forests of climate change. This study makes use of a long-term (12 year) through-fall exclusion (TFE) experiment in the Amazon Rainforest to evaluate the role of leaf-level water relations, leaf anatomy and their plasticity in response to drought in six tree genera. Water relations parameters, including turgor loss point, hydraulic capacitance and the elastic modulus, were compared between seasons and plots (control and TFE) enabling a comparison between short- and long-term plasticity in traits. The response to experimental drought was also analysed in leaf anatomical parameters such as the relative and absolute abundance of each tissue, vein and stomatal density, and the internal cavity volume. We found that osmotic adjustment occurred in response to the long-term drought treatment resulting in lower turgor loss points, but that taxa resistant to drought stress, based on mortality response to the experimental drought, showed less seasonal osmotic adjustment than drought-sensitive taxa. Anatomically, it was expected that trees would produce leaves of a more xeromorphic character in response to long-term soil moisture deficit. However, there was very little anatomical difference in leaves between plots. The only measured anatomical parameter that differed significantly in response to the drought treatment was the internal cavity volume which was higher in the TFE. The plasticity in leaf water relations suggests that, to some degree, tropical rainforest trees have the capacity to adapt to a long-term reduction in water availability, but the lack of anatomical response indicates that the extent of adaptation is most likely limited. Furthermore, our results show that the ability to perform seasonal osmotic adjustment is not a reliable indicator of the potential for taxa to adapt to long-term reductions in water availability.

O12-05 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

Functional responses of species of the genus Zamia (ZAMIACEAE - Cycadales) by human disturbances in its light habitat in tropical rainforests of the Biogeographic Chocó, Colombia - South America

LAURA ALEJANDRA GARCIA[1], LEIDY CAROLINA MENDEZ[2], OMAR MELO[3]
[1]Universidad Del Tolia, Forest Science, 730001, Ibague, Colombia
[2]Universidad Austral, Forest Science, 730001, Ibague, Colombia
[3]Universidad Del Tolima, Forest Science, 730001, Ibague, Colombia

In plant ecology there is a global pattern known as «leaf economics spectrum». On one side of the spectrum are the «acquisitive» and at the other extreme are «conservative» plants. However functional adaptations is unknown when the lighting habitat of individuals of the same species is affected by human disturbances. Functional traits in situ and habitat variables in four species of the genus Zamia (ZAMIACEAE - Cycadales) were studied to evaluate whether the functional features change between and within species and if there is a pattern related to the adaptation of species to the growth environment with human damages. The research was conducted in tropical rain forests located in the region of the Bajo Calima, Colombian Biogeographic Chocó. Coordinates 3°57,211' N and W. 76°59,439'. The average annual rainfall is 7467 mm. The average annual temperature is 26 ° C. This region is one of the wettest places in the world, with high biodiversity values. A plot of 40x250 m with units of 10x10m was established. In the center of each unit leaf area index (LAI), photosynthetically active radiation (PAR) and light extinction factor (K) was recorded. All individuals of the species Zamia amplifolia, Z. chigua, Z. oligodonta and Z. roezlii were evaluated. Z. amplifolia and Z. chigua are endemic species to Colombia. Total height of the plant, specific leaf area, leaf life span, concentration of nitrogen in the leaf, total phenols and root/shoot relationship were analyzed. Also mortality and recruitment was assessed. We identified two contrasting lighting habitats. The first is undisturbed forest areas with lower PAR= 12%; LAI= 4.7 and K= 0.7 (HLUD). The second corresponds to areas with high presence of light generated by harvesting trees with PAR= 60%, LAI= 1.0 and K= 0.2 (HLHD). In the HLUD Z. amplifolia and Z. oligodonta present acquisitive trends with high values of specific leaf area and lower Root/shoot relationship (0.75), leaf nitrogen is high (4.1%). Z. chigua and Z. roezlii showed a conservative trend with low specific leaf area (27.4) and higher root/shoot relationship (1.2), the leaf nitrogen is low (1.9 %). In HLHD the population density decreases and mortality rates increase. The annual recruitment decreases. We believe that this endangers the permanence of these species in the ecological community. These results can generate adaptation and conservation strategies for these species in this modified habitats by human damages.

O12-06 – S12 *Free session: Plant physiology, and ecology*
Monday 20 June 20 / 16:00-17:30 – Rondelet

Seasonal variation of leaf temperature in two common species of the paramo

ADRIANA SANCHEZ[1], CAMILO REY-SÁNCHEZ[2], JUAN M. POSADA[1], WILLIAM K. SMITH[3]
[1]Universidad del Rosario, Biology, 111221, Bogota, Colombia
[2]The Ohio State University, Civil, Environmental and Geodetic Engineering, 43210, Ohio, USA
[3]Wake Forest University, Biology, 27109, Winston-Salem, USA

Background: Changes in the global climate such as warming air temperatures are expected to severely impact high mountain ecosystems. In the Northern Andes, the Páramo occurs above 3000 m and it is characterized by its rich plant biodiversity and its provision of key ecosystem services such as water supply. Leaf temperature (Tleaf) variation is critical for accurately calculating net primary productivity, because both photosynthesis and respiration are highly sensitive to temperature. In order to understand the possible impact of increased air temperatures in the carbon flux of this ecosystem, it is important to establish how Tleaf is related to other environmental variables.
Method: We quantified the temporal variation of Tleaf, air temperature (Tair), vapor pressure (VP), photosynthetic photon flux density incident on leaves (PPFDl) and PPFD above the canopy (PPFD), in two common species (Espeletia grandiflora and Chusquea tessellata) of a tropical alpine ecosystem in Colombia during the wet and the dry season. A Structural Equation Model (SEM) was constructed to create an empirical model for predicting the response of Tleaf to these different environmental variables. We compared several alternative models for expected causal relationships between Tleaf, PPFD, PPFDl, air temperature (Tair), VP (vapor pressure) and time of day (TOD).
Results: The SEM that best explained changes in Tleaf included TOD, PPFD, PPFDl and Tair while VP was rejected. TOD had a strong relationship with PPFD in both seasons yet TOD relationship with Tair was weak in the wet season. Tair was strongly predicted by PPFD in both seasons. This modeling approach explained 97% of the variance of Tleaf in the wet and the dry season for E. grandiflora and 94% in the dry and 90% in the wet season for C. tessellata. The results of the model also showed that Tleaf is strongly predicted by Tair during the wet and the dry season with weak contributions of PPFD. However, during the wet season, a great part of the variation was also explained by PPFD, especially for C. tessellata.
Conclusions: These seasonal differences aid to the understanding of how different plants cope with the extreme environmental conditions of the Páramo. The causal relationship between Tleaf, Tair and PPFD can also improve carbon uptake models for the Páramo and other tropical alpine ecosystems.

O13-01 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

Identifying unique areas in the Congo Basin for conservation

ROXANNE LEBERGER[1], JAVIER MARTINEZ-LOPEZ[1], GRÉGOIRE DUBOIS[1], GRAEME BUCHANAN[2], CHARLES DOUMENGE[3], HENRIQUE PEREIRA[4]
[1]Joint Research Centre of the European Commission, Institute for Environment and Sustainability, 21027, Ispra, Italy
[2]Royal Society for the Protection of Birds, Conservation science, EH129DH, Edinburgh, United Kingdom
[3]CIRAD and OFAC, Campus international de Baillarguet, F-34398, Montpellier, France
[4]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, 04103, Leipzig, Germany

A major challenge in conservation biology is to identify areas to be protected in priority. With the hypotheses in mind that areas presenting unique environmental features when compared to their surroundings are more likely 1) to be vulnerable to changes and 2) hosting relatively more specialized species, we performed a global analysis to identify singular forested areas and further explored the relationship of those areas with forest bird richness and endemism.
Using a moving window of 50 x 50 km, we computed, across the earth's surface, on a grid of 5 x 5 km resolution the probabilities for each cell to find similar biophysical features elsewhere in the window. The input variables were, NDVI and NDWI, slope, and the percentages of grassland and tree covers. This systematic screening allowed us to map areas presenting unique features and to further correlate this information with the level of the correlation between bird endemism and species richness.
At the global scale, we found the forested biomes of the Congo Basin, namely the Tropical & Subtropical Moist Broadleaf Forests and the Tropical & Subtropical Grasslands, Savannas & Shrublands among the most homogeneous ones for what concern our environmental variables. While it is well-known that the Tropical Moist Forest is the biome holding the biggest diversity in terms of bird-species richness, the relationship between biomes and endemism levels is less documented. If we found that more than half of our variables explained bird endemism for the moist forests, such characterization of the level of endemism was not straightforward for other biomes. More relevant to the identification of potential new areas to focus on for biodiversity conservation, we found that the Tropical and Subtropical Moist Broadleaf Forests shown little ecological heterogeneity and consequently present only a few unique areas. Interestingly, while we found that the relationship between endemism and areas presenting unique environmental features was not obvious for most forested ecosystems, we found a significant relationship between endemism and habitat uniqueness for the Tropical and Subtropical Moist Broadleaf Forest.
It is the purpose of this contribution to discuss further our preliminary results and to contrast our findings with the current distribution of protected areas in the Congo Basin.

O13-02 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

IMET (Integrated Management Effectiveness Tool): an integrated tool for the Planning, Monitoring & Evaluation of protected areas

CARLO PAOLINI[1], PAOLO ROGGERI[2], PHILIPPE MAYAUX[3], MARIAGRAZIA GRAZIANO[4], FLORENCE PALLA[5], CARLOS DE WASSEIGE[6], OMER NTOUGOU[7], ANDREA MARELLI[8], DONALD JOMHA DJOSSI[8]
[1]Individual Expert, Protected Areas Management, I-52014, Poppi (AR), Italy
[2]European Commission, Joint Research Centre, I-21027, Ispra (VA), Italy
[3]European Commission, Europ Aid Co-operation Office (DEVCO), B-1000, Brussels, Belgium
[4]European Commission, Joint Research Centre, I-21027, Ispra (VA), Italy
[5]OFAC, Regional Coordinator, BP, Yaounde, Cameroun
[6]OFAC, Country coordinator, BP, Kinshasa, Republique Democratique du Congo
[7]RAPAC, Executive Secretary, BP 14533, Libreville, Gabon
[8]OFAC, IT Development, BP, Yaounde, Cameroun

Despite the efforts of conservation authorities and partners, protected areas (PAs) management is complex because of pressures and threats, non-respect of good governance principles, insufficient management capacities and resources for conservation and unclear Planning & Evaluation systems, often due to incomplete and unsatisfactory information.
To reverse this negative trend, it is essential to invest in better decisions taking, structuring and orienting information systems and strengthening the coordination of the different management aspects towards well-defined result-oriented actions.
IMET is conceived to establish a common understanding of the problems to solve and solutions to adopt between actors of conservation. It supports managers at field or central level to improve management effectiveness and the status of biodiversity conservation. Designed originally for the countries of Central and Western Africa, it's applicable for any protected area, terrestrial or marine.
It consists of 3 modules: 1) context of intervention, 2) management effectiveness, 3) visualization of the elements and analyses produced (Decision Support Systems, DSSs).
The Context Module provides general information on the PA and its external context, on the territory, on resources available for management, on values (species & habitats), threats, climate change and ecosystem services.
The Management effectiveness Module is built on the main existing works and tools. Automatically connected with the Context Module, it allows the detailed assessment of the management process, along the 6 steps of the PA Management Cycle.
Building on reliable statistical processing, the information is organized and deployed through data visualization tools (DSS) to support analysis and decision-making.
Data collection is the result of a self-assessment process, jointly carried out by PAs and HQs staff facilitated by duly trained "coaches". The full involvement of national PA Agencies is a key element of the process.
The use of IMET allows the definition of both strategic and management objectives, of indicators and of reference values (benchmarks) to ensure the necessary follow-up, over time in view of a proactive approach towards biodiversity conservation.
It may become a key tool in the Central Africa region. In this regard, ownership by the users, enforcement of result analysis capacities and the scaling-up from the PA to highest levels still require challenging action-research approach.

O13-03 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

Scientifically based biodiversity management in timber concessions: contribution to conservation and sustainable use of biodiversity

NICOLAS BAYOL[1], JEAN-FRANÇOIS CHEVALIER[1], CHARLES DOUMENGE[2], SYLVIE GOURLET-FLEURY[2], ALEXANDRA PASQUIER[1]
[1]FRMi, 34130, Mauguio, France
[2]CIRAD, Environnements et sociétés, 34398, Montpellier, France

During the past 25 years, forest laws in Central African countries have undergone major changes. Management plans were made mandatory: nearly 19 million hectares of timber concessions (38% of total granted concessions) were subject to a management plan in 2013 and the dynamics is currently underway.
The management plan is based on a set of technical and scientific studies, including statistical surveys (management inventories) covering the whole concession and taking into account all timber species, large mammals and the main non timber forest products. These inventories allow, at concession level, to characterize ecosystems and to assess the forest conservation values, through floristic and faunal biodiversity indicators and by taking into account threats to the forest ecosystems, especially anthropogenic ones. Such management inventories are used especially for planning and forecasting harvests, while minimising environmental impacts on the forest structure and functioning, and retaining regeneration capacities of the timber species and the forest ecosystems. The knowledge gained on specific and ecosystemic biodiversity helps to define management rules to ensure the sustainability of different timber species' populations, noticeably the exploited ones. It is also used to design areas within the concessions were exploitation will not take place due to conservation interest (most biodiversity-rich areas, protection of rare or endangered species...). Such so-called "conservation series" therefore complement the protected areas network.
Well-managed forest concessions can help conserve the regional forest ecosystems and maintain essential functions that they provide. However, management plans were up to now designed at the concession scale. Data acquired in forest concessions also significantly contribute to improve knowledge of the forest ecosystems and their functioning at the regional level. Using this data, the CoForChange Project (http://www.coforchange.eu) issued a map of the forest ecosystems developed in the "Sangha River Interval" region. This project suggested that those forest ecosystems could react differently to disturbance, and could need an adaptation of management methods to each ecosystem. Based on forest inventories, other initiatives are underway to map the forest types and the biomass stock at the scale of Central Africa, and might be of particular interest for policy decisions on forest ecosystems.

O13-04 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

Spatial modeling of the potential of agricultural or forestry production for sustainable land use planning

ROBIN GOULAOUIC[1], LAURENT GAZULL[2], LAURÈNE FEINTRENIE[3]
[1]Independent, GIS specialist, 44610, Nantes, France
[2]CIRAD, UR Tropical forests goods and ecosystem services, 34398, Montpellier, France

In Central Africa, oil palm is a major food-crop used in everyday cooking. All the countries of the region are importing palm oil, often from south-east Asia, to cover their domestic demand. Palm oil production is dominated by small scale agriculture, with a diversity going from the small backyard garden to the monospecific plantation of several hundred hectares. Most of the industrial plantations date from colonial periods. New industrial plantations have been expanding in the last decade, with successes and failures, with the help of southeast Asian and European multinationals and domestic investors.
The States want to increase their national palm oil production and industrial investments. They hope for socioeconomic benefits and food security. Such plans for agricultural development also present threats such as deforestation, loss of biodiversity and land use conflicts, and caution and planning are needed to avoid negative social and environmental impacts. In order to provide decision-makers with accurate information and useful decision-making tools to plan the development of the palm oil sector at national and sub-regional scales, the WWF asked CIRAD to map lands potentially favourable to the production of sustainable (P&C RSPO) palm oil in 5 countries of the Congo basin: Cameroon, Gabon, Republic of Congo, Democratic Republic of Congo and Republic of Central Africa. We use a step by step method to 1/ measure and locate territories which are suitable for oil palm culture, 2/ prevent threats over biodiversity and land use by respecting the social and environmental constraints edited by the principles and criteria of the Roundtable on Sustainable Palm Oil (P&C RSPO), 3/ plan development strategies for palm oil production which are coherent with the national context and specificities (through an evaluation of the adequacy of various production models).
The maps resulting from this study are useful decision-making tools that allow analysing trade-offs between opportunities of production and prevention of threats on biodiversity and land use issues. These maps can be useful in the design of national programs of agricultural development that avoid deforestation and preserve biodiversity corridors. Our results in Gabon are consistent with the maps of biodiversity and conservation importance produced by the National Agency of National Parks. In Republic of Congo, they are used in the discussions on the agricultural component of the REDD+ program.

O13-05 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

The case for a "conservation bank" to secure the future of the TRIDOM forest landscape

PAUWEL DE WACHTER[1], FABIEN QUÉTIER[2], MARIE MADELEINE BASSALANG[3], HELENE DESSARD[4], PAUL N'GORAN[5], DURREL HALLESON[5], EUGENE NDOUTOUME[1], JULIETTE CHAMAGNE[6], CLAUDE GARCIA[6]
[1]WWF, Gabon Country Office, PO BOX 9144, Libreville, Gabon
[2]Biotope, NA, 34140, Mèze, France
[3]Rainbow Environment Consult, NA, PO BOX 30137, Yaounde, Cameroon
[4]CIRAD, Biens et services des écosystèmes forestiers tropicaux, 34398, Montpellier, France
[5]WWF, Cameroon Country Office, PO BOX 6776, Yaounde, Cameroon
[6]ETH Zürich & CIRAD, Forest Management and Development, 8092, Zürich, Switzerland

The 178,000 km² Tri-National Dja –Odzala-Minkebe landscape (TRIDOM) is a transboundary rainforest shared by Cameroon, the Republic of Congo and Gabon. It is considered a stronghold for great apes and forest elephants. Protected areas cover 24% of the landscape and are ecologically connected by a large expanse of forest matrix.
Threats to the TRIDOM are considerable. Most of the forest in between the protected areas is allocated to logging companies. Elephant populations are declining rapidly because of ivory poaching. A new highway through the TRIDOM's heartland is being build. Hydropower projects such as the Chollet dam are being proposed. The area is also an emerging iron ore province, with several world class iron ore deposits. Under a business as usual scenario, the TRIDOM will progressively cease to exist as a large intact forest landscape, with interconnected patches of high quality forest, and be reduced to a fragmented landscape with isolated protected areas, with most of the large fauna disappearing from the matrix. Elephants, in particular, are key dispersers of plant species and the loss of long-distance connectivity could negatively affect the forest's capacity to respond to change through shifts in the distribution of species. The successful implementation of a net biodiversity gain policy by the proposed mining and hydro projects could leverage significant additional conservation in TRIDOM, through biodiversity offset commitments. Together with careful siting and minimization measures, an aggregated offset project for mining and hydro developments could be designed to provide effective large mammal conservation, and ensure long-distance connectivity is maintained. But, with the mining projects on hold, due to the recent fall in iron ore prices, such a project appears to be a distant prospect. However, with the right institutions in place, investors may be willing to secure land for an aggregated offset, in anticipation of future offset needs. This could ensure the matrix forests are protected before it is too late, with considerable benefits to biodiversity and ecosystem services, and investors could get a return by offering offsets to developers when commodity prices rise again. Such as system is analogous to establishing a "conservation bank" for the TRIDOM, which raises a number of technical and organizational challenges. We discuss these in the light of similar systems elsewhere.

O13-06 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

Place of customary rights mapping initiatives in conservation policies

VERMEULEN CÉDRIC[1], KARSENTY ALAIN[2]
[1]ULG/Gembloux, Biose, 5030, Gembloux, Belgique
[2]CIRAD, Besef, 75116, Paris, France

In Africa, participatory mapping of land use by local people is a quite old field practice in conservation or development projects. More recently, massive on line mapping of customary rights were born under the impulse of activist NGO. These include The Mapping for Right Initiative which notably proposed to communities to prove by themselves their presence inside the forest. The announced purpose is to help the decision-makers and the private sector to recognize this presence and help international community to recognize rights linked with this presence. Promoted as a decision making-tool, this initiative try in fact to make recognize customary rights at large scale in order to put them against land management and planning (logging concession, protected areas…). The important things is that conservation world take it into consideration not as an constraint but as an opportunity. We propose as line of conduct three possibilities i) for existing protected areas, mapping of rights should promote more participation of local population in decision structure and access to benefits-sharing, but exclude rights of hunting ii) for new protected areas, mapping of rights will help the free prior and informed consent process and should lead to land sharing based on overlapping rights officially acknowledged through contracts (participation in decision structure, sharing benefits), with village hunting areas outside and around this new protected area and iii) about non protected areas where wildlife is still abundant, mapping of rights should promote community-based management and hunting rights on non-protected species.

O13-07 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

A legal approach to biodiversity conservation and forest rights of indigenous peoples in the Congo Basin: towards new legal tools

ARMELLE GUIGNIER[1], PHILIPPE KARPE[2], LAURENCE BOUTINOT[2]
[1]Environmental Law Expert, independant, member of IUCN World Environmental Law Commission, Environmental Law Expert, 71490, ST-MAURICE-LES-COUCHES, France
[2]CIRAD, UR 105 - Bsef, 34398, Montpellier, France

The livelihood of almost all indigenous peoples of the Congo basin depends on their free access to the forest natural resources. At present, some technical and legal means exist to improve the forest rights of indigenous peoples but the main question is what indigenous peoples themselves would request to truly fit their needs while conserving biodiversity. Based on the case of the Democratic Republic of Congo, this paper will explore the possible legal solutions such as protected areas and their various forms of governance and discuss the most/less suitable options and their conditions. Indeed, Indigenous peoples' and community conserved territories and areas (ICCAs) have been highly debated over the past few years, along with participatory management. If those models could support both IP livelihoods and biodiversity conservation in some protected areas, their implementation could be the first step towards the creation of a new form of "protected area" created and managed by indigenous peoples. This paper will therefore discuss this option further and put it in the broader context of the Congo basin.

O13-08 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
Monday 20 June 20 / 11:00-15:30 – Barthez

The OFAC: Interface between science and policy decisions on forest conservation and protected areas

MARTIN TADOUM
COMIFAC, Yaoundé, Cameroon

The conservation of biodiversity and sustainable forest management are facing many challenges in the Central Africa region. Indeed the growing demand of agricultural products and the increase of ore exploration and exploitation in many countries have put a pressure on land use. We are then assisting to the conflict of forested area and other land use sector.
The OFAC (Observatoire des Forêts d'Afrique Centrale) has been set up under the authority of the Central African Forest Commission (COMIFAC) for favoring scientifically based policy decisions. So, OFAC is a unique regional observatory dedicated to the forest resources of the central African region. Since its inception in 2007, OFAC is still implemented by the JRC in co-operation with a consortium of scientific institutions thanks to the European Union funding.
OFAC collects, verifies, harmonizes and disseminates information about forest ecosystems of the Congo Basin in order to improve governance and sustainable management of forest ecosystems by the decision makers and other stakeholders.
The approach adopted which relies on human resources in the region, makes the development of OFAC a true exercise in capacity building at both the national and regional level. The principal data providers are COMIFAC and its regional partners (e.g. RAPAC), the ministries responsible for forest management and the environment, etc.
The main outputs of the observatory are a detailed web-based information system (http://observatoire-comifac.net/index.php) and the production of the State of central African forests.
Referring to the missions and the products delivered by OFAC, it is unanimously accepted that the observatory is an excellent tool for Central Africa region. But, the observatory is facing some difficulties like the misunderstanding of its legal status by the national focal points. Due to that wrong understanding, there is an insufficient ownership of the observatory by the focal points, the OFAC national groups and other key national stakeholders. Moreover, there is less recognition of OFAC by other actors.
Based on the new challenges in the forest sector, the role of the observatory will increase in the future. As recommended by the recent business plan study conducted by COMIFAC Executive Secretariat, the COMIFAC ministers have to give a legal status to OFAC by adopting the legal and institutional framework which will enable the observatory to fully play its role as a scientific platform for decision-makers.

O14-01 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Mapping diversity and distributions across spatio-temporal scales; capturing the details

HUGHES ALICE
Xishuangbanna Tropical botanical garden, Chinese academy of sciences, Centre for Integrative Conservation, Menglun, 666303, Jinghong, China

Traditionally some of the greatest challenges to modeling species distributions have been highly endemic regionally restricted and dispersal limited species, and at the other end of the spectrum migratory species with an extensive range, but changing across the year. Without careful attention any attempt to model either of these groups may prove equally naïve, by failing to adequately capture the relationships between species and their "niche" at an appropriate and representative spatio-temporal scale. Here we demonstrate methods to accurately capture and represent both these scenarios, using the highly endemic amphibian species of China and the Migratory wading birds of the East Asian-Australasian Flyway.
In the case of amphibians developing variables that capture the microhabitat and biogeographic determinants which may limit dispersal proves all important, whereas in migratory wading birds must be segregated temporally to capture various annual behaviours which control their changing relationships with the environment across the year.
Here we describe the patterns of diversity, endemism, and community composition for both groups, explore the relative influences of a suite of environmental variables and how these patterns vary across space and time. We also discuss the value of developing such approaches and how we can use GIS approaches in sophisticated ways to attain novel perspectives into species distributions and ultimately better inform further research and management for groups where significant parts of the range are impossible to survey, and where constraints that vary across both space and time must be incorporated to adequately capture species habitat requirements and map their distributions.

O14-02 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Patterns of taxonomic, phylogenetic, and functional avian diversity along a rainfall gradient on the Rio Branco basin, a white-water Amazonian River

LUCIANO NAKA[1], THIAGO LARANJEIRAS[4], GISIANE RODRIGUES LIMA[3], THIAGO GONÇALVES[2]
[1]Universidade Federal de Pernambuco, Zoology, 50670-901, Recife, Brazil
[2]Universidade Federal Rural de Pernambuco, Ecology, Recife, Brazil
[3]Instituto Nacional de Pesquisas da Amazônia, Ecology, Boa Vista, Brazil
[4]Universidade Federal do Amazonas, Biodiversidade, Manaus, Brazil

Amazonia harbors the world's largest continuous block of tropical forest, which is drained by a spectacular river system. The seasonal level fluctuations of Amazonian rivers create a mosaic of river-created habitats, with a very specialized avifauna. The Rio Branco, located in the Brazilian state Roraima, northern Brazil, represents a relatively minor river for Amazonian standards, but despite being only 550 km long, it crosses one of Amazonian's largest rainfall gradients (1,100-2,600 mm/yr). Our main goal was to describe avian distribution patterns along the river and investigate the effect of the rainfall gradient in the flooded forest avifauna, particularly in terms of taxonomic, phylogenetic, and functional diversity. We conducted standardized 450 point-counts in 15 localities systematically distributed every 50 km throughout the basin, including the entire Rio Branco and two of its main tributaries. We catalogued a total of 430 bird species, but only a third of these occurred along the entire river. We found significant differences in the avifaunas of the upper and the lower sections of the river: ~25% of the species (112) are restricted to the flooded forests of the more humid lower Rio Branco, whereas ~10% (39) are restricted to the drier upper sections. We found no significant differences in the number of species and individuals along the rainfall gradient, but we detected a significant relationship between rainfall and the avian community. The rainfall gradient investigated explains most of the variation in species composition, which is mostly due to species turn-over, rather than nestedness. Finally, we found a significant effect of the rainfall gradient on both, the avian community phylogenetic structure and patterns of phylobetadiversity. Our results also suggest a significant role of the studied gradient on levels of functional diversity. This study is the first of the type to show the pervasive effect of rainfall in organizing and defining spatial patterns of avian communities in the Amazon basin. This is particularly meaningful due to the plans of the Brazilian government to build a large dams throughout the basin. Our results suggest that Amazonian rivers do not necessarily represent homogeneous biogeographical units, and that hydroelectric projects need to address these differences before flooding important transitional areas.

O14-03 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Three strands of progress in plant ecological strategies

WESTOBY MARK
Macquarie University, Dept of Biological Sciences, Balaclava Road, 2109, Sydney, Australia

Plant ecological strategy research changed gear in the 1990s with the suggestion that measurable species traits should be used directly as strategy dimensions. This opened a path to world-scale comparisons. And indeed, over the past 20 years a satisfying quantitative picture has been built about the constellation of species ecologies worldwide. Yet meanwhile, major problems have been left unresolved. Recent progress is summarised on some of these. (1) Indicators of temperature preference have been lacking. Leaf size turns out to be related to temperature at high but not at low rainfall, via its influence on night-time cooling more than on daytime heating. (2) Consistent influences of traits on competition have been quantified in a synthesis spanning 3 million trees in 140,000 plots. The trade-off is strong whereby traits favouring fast growth during early succession render species less shade-tolerant during later succession. Competition is more severe within than between species, but trait dissimilarity has almost no value as a predictor of between-species competition. (3) Persuasive models are beginning to emerge for competition and community assembly of plant strategies as influenced by their traits. Fitness landscapes generated in these models include both sharp peaks and broad nearly-level plateaux, with implications for the niche vs neutral debate.

O14-04 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Scale-dependent determinants of taxonomic diversity of freshwater fish assemblages in small streams of French Guiana

KÉVIN CILLEROS[1], LUC ALLARD[2], SÉBASTIEN BROSSE[1]
[1]CNRS, Université Toulouse III Paul Sabatier, ENFA, Laboratoire Evolution et Diversité Biologique, 31062, Toulouse, France(
[2]HYDRECO, Laboratoire Environnement de Petit Saut, 97388, Kourou, Guyane

The spatial patterns of biological diversity are shaped by a series of factors acting at different spatial and temporal scales. For instance, the local habitat determines the niche availability, whereas the historical and biogeographic context is approached using variables measured at higher scales. Our aim was to quantify the relative role of the local habitat, upstream-downstream gradient and river basin membership on the fish species richness and composition of 150 Guianese small stream sites.

Fish assemblages and a set of environmental variables (instream habitat, topology, physical chemistry and river basin context) were recorded at each site. We first quantified the influence of those environmental variables on the local species richness, while accounting for the spatially nested structure of the data. Then we evaluated the relative effect of regional, reach and site processes on the assemblage composition. We finally tested if those results are equally supported by the different fish orders, by analyzing separately the determinants of local composition for the main fish orders: Characiformes and Siluriformes.

Reach and local scale effects were the best predictors of the local species richness, which increased with the distance to the source and with local habitat complexity, and decreased with altitude revealing that similar processes shape fish assemblages in both temperate and tropical streams. Those processes were shared across orders. This implies that general theories on richness developed for entire fish fauna may also be true for different orders irrespective of their ecological differences. Turning from the species richness to the composition of species assemblages revealed that the site characteristics explained the highest variation in assemblage composition, although reach and basin effects remained significant. This permitted to distinguish four types of Guianese stream sites, with distinct fish faunas reflecting their ecological requirements: the upstream torrential sites, the muddy lowland streams, the forest sandy streams and the downstream sites located close to the confluence of a larger river.

Our results provide a first typology of Guianese small stream sites and show the preeminent role of instream habitat characteristics in local fish composition. This highlights that anthropogenic disturbances affecting local fish habitats (such as gold mining and deforestation) are prone to profoundly affect the fish assemblage structure.

O14-05 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Appraisal and prospects on pangolin DNA forensics: how DNA may help tracing the trade of the most heavily poached mammals?

PHILIPPE GAUBERT[1], SYLVAIN DUFOUR[2], FLOBERT NJIOKOU[3], HUARONG ZHANG[4], SHU-JIN LUO[5], AGOSTINHO ANTUNES[6]
[1]IRD, Université de Montpellier - ISEM, 34095, Montpellier, France
[2]SYLVATROP, Nantes, 44000, Nantes, France
[3]Université de Yaoundé I, Laboratoire de Parasitologie et Écologie, BP812, Yaoundé, Cameroun
[4]Kadoorie Farm and Botanic Garden, Lam Kam Road, Tai Po, Hong Kong, China
[5]School of Life Sciences, Peking-Tsinghua Center for Life Sciences, 100871, Beijing, China
[6]Universidad do Porto, Centro Interdisciplinar de Investigação Marinha e Ambiental, 4050-123, Porto, Portugal

Pangolins (Mammalia, Pholidota) are scaly ant-eaters classified into eight extant species from tropical Africa and Asia. They constitute Evolutionarily Distinct and Globally Endangered (EDGE) species of high conservation concern, and are considered the most heavily poached mammals in the world. Pangolins are locally consumed for their meat and globally traded between Africa and Asia to answer the overwhelming demand from the Chinese traditional medicine market. Pangolins are processed and sold under different forms (e.g. smoked or peeled carcasses, packs of scales, embryos) rending difficult their visual identification without envisaging a molecular diagnosis. However, to date DNA forensics has been rarely applied to the issue of pangolin trade, and more generally pangolins still suffer a lack of molecular diversity assessment. We review the available evidence in the literature and demonstrate the application, potential and current limitations of DNA forensics applied to the pangolin trade by developing four case studies using nucleotide sequencing and englobing the African and Asian continents. First, we highlight a series of misleading taxonomic labelling in public nucleotide sequence repositories that proves deleterious for the molecular identification of pangolin species based on "traditional' mitochondrial markers. Second, we apply DNA barcoding to large seizures of pangolin scales from Hong Kong, and show that Sunda pangolins (Manis javanica) were harvested over wide geographical areas across Southeast Asia. Third, we describe the phylogeographic structure of the most traded African pangolin species (the common or white-bellied pangolin Manis tricuspis) and provide strong evidence for the utility of mitochondrial and nuclear markers in the tracing of its inter-regional trade across Africa. Fourth, we exemplify the great potential of next-generation sequencing technologies in providing hundreds to thousands of diagnostic sites across various taxonomic levels in pangolins. Our review shows that DNA forensics is a promising avenue that should assist law enforcement and the national organisms and conservationists involved in the regulation and control of the pangolin trade around the world. However, correct taxonomic attribution, denser geographic/taxonomic sampling and higher gene coverage are needed to improve the genetic material available to date in public repositories.

O14-06 – S14 *Mapping diversity: from gene to system*
Monday 20 June 20 / 16:00-17:30 – Barthez

Environmental harshness determines macroscale patterns of floristic turnover across South American woody plant communities

DANILO NEVES[1], KYLE DEXTER[2], TOBY PENNINGTON[3], BENTE KLITGAARD[1], ARY OLIVEIRA-FILHO[4]
[1]Royal Botanic Gardens, Kew, Identification and Naming, TW9 3AB, Richmond, UK
[2]University of Edinburgh, School of GeoSciences, EH9 3JN, Edinburgh, UK
[3]Royal Botanic Garden Edinburgh, Tropical Diversity, EH3 5LR, Edinburgh, UK
[4]Universidade Federal de Minas Gerais, Botany, 31270-901, Belo Horizonte, Brazil

Background: Previous research has suggested that water stress is the key factor limiting the distribution of South American woody plant species. While there is evidence supporting this hypothesis for particular taxa and locations, the challenge of sampling plant communities spanning the highly heterogeneous environmental conditions of South America has prevented testing the importance of other potential environmental drivers (e.g., temperature, edaphic conditions). Here, we evaluate how environmental variation influences the distribution of 8,813 woody plant species across tropical and subtropical lowland South America.
Methods: To address this issue at the macroecological scale we examine a large floristic dataset, consisting of 3,071 woody plant community surveys from across South America and combined this with data for 28 environmental variables (http://prof.icb.ufmg.br/treeatlan/, Oliveira-Filho 2015). We asked: (1) how are environmental gradients constraining woody plant species from across South America?; and (2) how these woody plant species may respond to future climate change? We assessed the relative contribution of spatially autocorrelated processes and environmental factors to the floristic turnover from across South American woody plant communities using variation partitioning methods. In addition, we used multivariate analyses to determine which environmental factors were most important in explaining the turnover in current and future environmental conditions.
Results: Here we show that temperature, not water stress, is the main driver of floristic turnover across South American woody plant communities. Cold-tolerant and dry-tolerant taxa are disproportionally widespread across the temperature and precipitation gradients, respectively, with most reaching even the warmest and wettest climates, respectively. We also find that most taxa analysed are confined to warm and wet areas, and that in future climatic conditions, 13% (916 species) and 2% (145) of these taxa, respectively, will likely lose their entire climatic space.
Discussion: The continental-scale environmental limitation showed here has important conservation implications for the worlds' richest flora. If temperature and water stress increase across South America, as many studies predict, more species will be threatened with extinction in warm and wet areas, because the taxa confined to these climatic conditions have narrower climatic tolerances.

O15-01 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

The variation of productivity and its allocation between African, Asian and Neotropical forests

YADVINDER MALHI[1], SAM MOORE[1], STEPHEN ADU-BRED[2], AKWASI DUAH-GYAMFI[2], SHALOM, ADDO-DANSO[2], GLORIA DJAGBLETEY[2], LEE WHITE[3], KATH JEFFERY[3], VIANET MIHINDOU MIHINFOU[3], CARL STECY DITONGOU[3], JOSUE EDANG NDONG[3], FIDELE EVOUNA ONDO[3], LEANDRE OYENI AMONI[3], NATACHA NSSI BENGONE[3], TERHI RIUTTA[1], CHRIS DOUGHTY[1], CECILE GIRARDIN[1], ALEX MOREL[1]
[1]University of Oxford, Environmental Change Institute, School of Geography and the Environment, OX13QY, Oxford, UK
[2]Forest Research Institute of Ghana, Kumasi, Ghana
[3]ANPN, Libreville, Gabon

The net primary productivity (NPP) of a forest decribes its rate of production of organic matter, mainly in canopy, wood and fine roots. Recent years have seen an advance in the description of NPP in tropical forests and its variation across environmental gradients. Thus far all reported studies have been from the Americas and, to a lesser extent, Asia. Notably, there have been no reported studies from Africa. Here we present a comparison of NPP and its components in old-growth and logged forests across all three continents, based on identical protocols employed in plots from the GEM (Global Ecosystems Monitoring) network (24 plots in Amazonia, 10 in Asia and, notably, 24 in Africa, the latter in Ghana, Gabon and Ethiopia). We explore if there is a consistent relationship between NPP allocation, climate and soil nutrients across continents, or whether there is evidence of a biogeographical influence causing differences in productivity and carbon cycling across continents.

O15-02 – S15 *Ecosystem ecology of african forests*
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Carbon cycling across environmental gradients in West and Central African tropical forests

SAM MOORE[1], YADVINDER MALHI[1], STEPHEN ADU-BREDU[2], AKWASI DUAH-GYAMFI[2], SHALOM ADDO-DANSO[2], LEE WHITE[3], VIANET MIHINDOU MIHINDOU[3], NATACHA NSSI BENGONE[3], FIDELE EVOUNA ONDO[3], JOSUE EDANG NDONG[3], CARL-STECY DITOUGOU[3], KATHRYN JEFFERY[3], LEANDRE OYENI AMONI[3]
[1]University of Oxford, Environmental Change Institute, OX1 3QY, Oxford, UK
[2]Council for Scientific and Industrial Research, Forestry Research Institute of Ghana, P. O. Box UP 63 KNUST, Kumasi, Ghana
[3]Agence Nationale des Parcs Nationaux, ANPN, B.P. 20.379, Libreville, Gabon

Tropical forests cover 7–10% of the global land area, yet they store 40–50% of carbon in terrestrial vegetation. They account for 60% of global terrestrial photosynthesis (Malhi & Grace, 2000) and about one-third of global net primary productivity (NPP; Field et al., 1998). In recent years, the full carbon cycle has been described for a handful of sites restricted to the Neotropics, but to date, no such descriptions exist for one-third of the world's tropical forests in Africa. Through a network of long-term forest monitoring plots in West and Central Africa, here, I present the first ever complete carbon cycling datasets for African tropical forests. Over the past three years, above- and belowground productivity (NPP), autotrophic and heterotrophic respiration as well as microclimate and soil data has been collected at six sites (20 one-hectare plots) in Ghana and Gabon. These data help to determine how the ratio of NPP to GPP, often termed as the carbon use efficiency (CUE), varies in contrasting tropical forests. Results presented from the network of plots encompass a range of natural gradients, from a rainfall gradient in Ghana that spans wet-evergreen forests to the forest-savanna transition zone to an elephant population density gradient across Gabon.

O15-03 – S15 *Ecosystem ecology of african forests*
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Soil and Necromass Carbon Dioxide efflux in a moist semi-deciduous forest under recovery from selective logging in Ghana

STEPHEN ADU-BREDU[1], ADU OPOKU-AMEYAW[1], MICKEY BOAKYE[1], AKWASI DUAH-GYAMFI[1]
SHALOM ADDO-DANSO[1], GLORIA DJANEY DJAGBLETEY[1], SAM MOORE[2], YADVINDER MALHI[2]
[1,2,3,4]Forestry Research Institute of Ghana, Biodiversity Conservation and Ecosystem Service, UP, Kumasi, Ghana
[5,6]Forestry Research Institute of Ghana, Forest and Climate Change, UP, Kumasi, Ghana
[7,8]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, United Kingdom

Carbon dioxide (CO2) fluxes from necromass and soil play very important role in the carbon budget of the forest ecosystem. These components are sometimes not quantified correctly during carbon accounting, leading to uncertainties. Though soil is a large repository of carbon, it also releases carbon into the atmosphere via soil respiration, a process which is a great contributor in the global carbon cycle. Studies conducted on belowground carbon dynamics in the African tropical forest ecosystems focused on stocks, with inadequate information on the fluxes of soil CO2. This study was carried out in Bobiri Forest Reserve, a moist semi-deciduous forest in Ghana, under recovery from selective logging, represented by post-logged-years sites. The sites were 12- (Y12), 22- (Y22), 55- (Y55) post-logged-years sites and a Strict Nature Reserve (SNR) with no logging history. The objectives were to quantify the necromass CO2 efflux and investigate seasonality, magnitude and abiotic controls of total soil respiration. The contributions by various components to total soil respiration were also investigated. Closed chamber method was used to measure soil and necromass respiration at monthly intervals over a period of one year, by means of infrared gas analyser. The coarse woody debris CO2 efflux levels were high in the highly decomposed categories in the Y55 and SNR. The total CO2 efflux ranged from 0.13 (±0.04 SE) in Y22 to 0.22 (±0.07 SE) MgCha-1 year-1 in SNR. Total soil respiration had a strong seasonal influence with the values in the wet season being higher than those in the dry season. The total soil respiration was estimated to be 18.03 and 17.83 MgCha-1 year-1 at the 12- and 55-year-old sites, respectively. The contribution to total respiration by roots and rhizosphere was 24.02 and 34.58 %, mycorrhizae was 16.97 and 14.26 %, litter was 27.42 and 25.17 % and soil organic matter was 31.59 and 25.99 % for the 12- and 55-year-old post-logged sites, respectively. The 55-year-old post-logged site thus exhibited a higher autotrophic respiration proportion of 48.84 % compared to a value of 40.99 % by the 12-year-old post-logged site. Soil moisture had a greater influence on soil respiration than soil temperature. Forest age had greater influence on soil respiration, and the partitioning of total soil respiration into the various components well depicted the contribution from autotrophic and heterotrophic respiration.

O15-04 – S15 *Ecosystem ecology of african forests*
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Comparative Ecology of African Tropical Forests: A pan-tropical synthesis

SIMON LEWIS, OLIVER PHILLIPS, WANNES HUBAU, MARTIN SULLIVAN, LAN QIE, AFRITRON CONSORTIUM, RAINFOR CONSORTIUM
University of Leeds, Geography, E17 7HA, Leeds, UK

Background: The world's second largest expanse of closed-canopy tropical forest occurs in Africa, but is little studied compared to Amazonia and Southeast Asian forest.
Methods: Here we utilise the African Tropical Rainforest Observation Network (AfriTRON) of ~400 long-term monitoring plots across 12 African countries, where all stems >10 cm diameter are measured and identified, plus RAINFOR (Amazonia) and other standardised plot data to compute standardised ecological parameters for African tropical forests, and them compare with parameters derived from similar networks in Amazonia and Asia.
Results: African tropical forests have very low stem density compared to other forests; are, on average, taller forest than typical Amazonian forests, but similar height to Asian forests; have higher aboveground biomass than most Amazon forests, but similar biomass to Asian forests; have much lower alpha-diversity than Amazonian and Asian forests, and lower beta- and gamma-diversity. Additional results will also be presented.
Discussion: African forests have unique historical biogeographic circumstances, notably a much more intact megafauna community than either Amazonia or SE Asia, and large reductions in forest area in glacial periods. This may substantially explain why the three major blocks of the world's tropical forests differ greatly from one another in terms of forest structure, function and diversity, and implies likely differing outcomes from today's global environmental changes.
Conclusion: African tropical forests differ substantially in terms of both structure and composition when compared to Amazonian and SE Asia forests.

O15-05 – S15 *Ecosystem ecology of african forests*
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Regional scale mapping of forest types, biomass and degradation in Cameroon using a ground inventory network and canopy texture on VHR optical imagery

NICOLAS BARBIER[1], PIERRE PLOTON[5], LIBALAH MOSES[2], VINCENT DROISSART[1], NICOLAS TEXIER[4], PATRICK HOUDRY[3], BONAVENTURE SONKÉ[2], RAPHAEL PELISSIER[1], PIERRE COUTERON[1]
[1]IRD, UMR AMAP, 34398, Montpellier, France
[2]University of Yaounde I, Plant Systematic and Ecology Laboratory, B.P. 047, Yaoundé, Cameroon
[3]Airbus Defence and Space, -, 31402, Toulouse, France
[4]Université Libre de Bruxelles, Unité de recherche Evolution biologique et Ecologie, Herbarium et Bibliothèque de Botanique Africaine, B1050, Bruxelles, Belgique
[5]Institut des sciences et industries du vivant et de l'environnement, 34090, Montpellier, France

Investigating gradients in rainforest structure, composition and dynamics at regional scale is hampered by the low representativeness of ground data and by signal acquisition, saturation and stability issues of currently affordable remote sensing (RS) approaches. Over ten years of methodological development of canopy texture-based methods like the Fourier Transform Textural Ordination (FOTO) and the advent of a new constellation of large swath very high resolution (2m panchromatic) SPOT 6&7 multispectral satellites offer a new solution.
A full-scale demonstration was undertaken over 4000 km^2 in SE Cameroon, thanks to the funding of the European Institute of Technology (EIT-Climate KIC), through project FOREST - Fully operational and reliable Emissions tools, Airbus DS as prime contractor. Ground data consisted in a plot network of about 100 1ha plots comprising detailed information of forest structure and composition. Radiometric and FOTO texture features were extracted from eight SPOT 6&7 images and inter-calibrated for atmospheric as well as directional reflectance and texture variations. Due to the diversity of forest types, using the plot network for a direct calibration of RS-based prediction models for forest structure/biomass proved difficult. We therefore included an intermediate analysis level using a collection of Pleiades and GeoEye imagery with sub-metric spatial resolution to bridge the gap between ground and SPOT-derived texture maps. Temporal dynamics of forest canopy were also investigated with the help of inter-calibrated texture features on multi-temporal image sets.
Marked local and regional variations were measured in forest structure and composition, in both ground and remote sensing data, and could be mapped over the study area with a minimum mapping units of a few ha, i.e. at a scale compatible with the size of ground observation units. Forest degradation events as small as individual tree removals, as well as subsequent regrowth dynamics were detected by temporal texture changes, and were consistent with reliable accounts of logging activities in forestry concessions.
The maps obtained are both precious for our understanding of broad scale, poorly known ecological drivers in African rainforests, and as a demonstration of the operational feasibility of forest mapping and degradation monitoring in the context of forest management, conservation and carbon accounting in developing countries.

O15-06 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

Carbon sequestration and biodiversity following active tropical forest restoration: 18 years of change in Kibale National Park, Uganda

CHARLOTTE WHEELER[1], PATRICK OMEJA[2], COLIN CHAPMAN[3], MARTIN GLIPIN[4], CHARLES TUMWESIGYE[5], SIMON LEWIS[1]
[1]University College London, Department of Geography, WC1E 6BT, London, UK
[2]Makerere University Biological Field Station, Ecology, P.O. Box 967, Fort Portal, Uganda
[3]McGill University, School of Environment and Department of Anthropology, H3A 2T7, Montreal, Canada
[4]University of Leeds, School of Geography, LS2 9JT, Leeds, UK
[5]Uganda Wildlife Authority, Research, P.O Box 3530, Kampala, Uganda

Background - Vast areas of degraded tropical forest, combined with increasing interest in mitigating climate change and conserving biodiversity, demonstrate the potential value of restoring tropical forest. However, there is a lack of long-term studies assessing active management for restoration. Here we investigate above-ground biomass (AGB), forest structure, and biodiversity, before degradation (in old-growth forest), after degradation (in abandoned agricultural savanna grassland), and within a forest the is actively being restored in Kibale National Park, Uganda.
Methods - In 1995 degraded land in Kibale was protected from fire and replanted with native seedlings (39 species) at a density of 400 seedlings ha-1. Sixty-five plots (50m x 10m) were established in restoration areas in 2005 and 50 of these were re-measured in 2013, allowing changes to be assessed over 18 years.
Results - Degraded plots have an Above Ground Biomass (AGB) of 5.1 Mg dry mass ha-1, of which 80% is grass. By 2005 AGB of trees ≥10 cm DBH was 9.5 Mg ha-1, increasing to 40.6 Mg ha-1 by 2013, accumulating at a rate of 3.9 Mg ha-1 year-1. A total of 153 planted individuals ha-1 (38 %) remained by 2013, contributing 28.9 Mg ha-1, or 70% of total AGB. Eighteen years after restoration, the plots had 12% of old-growth AGB (419 Mg ha-1). If current accumulation rates continue restoration forest would reach old-growth AGB in 96 years. Biodiversity of degraded plots prior to restoration was low with no tree species and 2 seedling species per sample plot. By 2005 restoration areas had an average of 3 tree and 3 seedling species per sample plot, increasing to 5 tree and 9 seedling species per plot in 2013. However, biodiversity was still significantly lower than old-growth forest, at 8 tree and 16 seedling species in the equivalent area.
Conclusions - The results suggest that forest restoration is beneficial for AGB accumulation with planted stems storing the majority of AGB. Changes in biodiversity appear slower; possibly due to low stem turnover. Overall this restoration treatment is an effective means of restoring degraded land in the area, as can be seen from the lack of regeneration in degraded plots, which remain low-AGB and diversity, largely due to the impacts of fire and competition with grasses.

O15-07 – S15 *Ecosystem ecology of african forest*
Tuesday 21 June / 10:00-15:30 – Pasteur

Comparing the Foraging Impacts of Asian vs. African Forest Elephants on Tropical Forest Structure and Biodiversity

JOHN TERBORGH[1], LISA DAVENPORT[2], LISA ONG[3], AHIMSA CAMPOS-ARCEIZ[3]
[1]Duke University, School of the Environment, 27708, Durham NC, USA
[2]University of Florida - Gainesville, Florida Museum of Natural History, 32611, Gainesville FL, USA
[3]University of Nottingham Malaysia Campus, School of Geography, Semenyih, Selangor, Malaysia

Comparison of Gabonese forests supporting forest elephants and other large herbivores and Amazonian forests lacking megafauna suggested that megafaunal herbivory imposes a strong filter on tree recruitment by killing or damaging many saplings. Here we extend the research to Malaysia, comparing sites at which Asian elephants were common vs. absent. We employed the same nested vegetation sampling protocol we had used previously in Africa and Amazonia, applying it to multiple sites in Royal Belum State Park (elephants abundant) and Krau Wildlife Reserve (elephants absent for ~ 25 years). We found no difference between the two localities in the density of small stems (<1 m tall) and the density and diversity of trees ≥10 cm dbh, but saplings (≥1 m tall and >10 cm dbh) were at reduced density and less diverse at Royal Belum, supporting the view that Asian elephants also act to filter tree recruitment. Palms were much more abundant at Krau, with differences being much stronger at larger sizes (>1 m high). Among non-palm monocots, small stems were more abundant at Belum than at Krau, but almost disappeared from larger size classes at Belum. Unexpectedly, the height distribution of breakage scars on re-sprouted stems was lower at Belum than Krau. In conclusion, browsing by Asian elephants appears strongly directed at monocots, with reduced impacts on dicots compared with African forest elephants. The extent to which browsing by the two species regulates tree diversity remains to be more fully investigated.

O15-08 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

The aboveground biomass of Gabon's forests

POULSEN JOHN
JOHN POULSEN[1], VINCENT MEDJIBE[1], SASSAN SAATCHI[2], LEE WHITE[3]
[1]Institution : Duke University - Department : Nicholas School of the Environment, 27708 Durham - USA,
[2]Institution : California Institute of Technology - Department : Jet Propulsion Laboratory, California Institute of Technology Pasadena - USA

Deforestation and forest degradation release the dense carbon stocks of the worlds tropical forests accelerating climate change and diminishing ecosystem services. Although still inadequate, sizable networks of forest plots now exist in the tropics, advancing our understanding of carbon dynamics. But most of these plots were established in pristine or near pristine forests, raising the question of how well they can be generalized to all forests. We use the Gabon national resource inventory, composed of 104 1-ha forest plots located in a systematic, random design, to evaluate: (1) What are the differences in aboveground biomass (AGB) and forest architecture between pristine and disturbed forests? (2) What are the drivers of AGB, and what is the effect of human activities? (3) Can large trees be used to predict AGB? Between February 2011 and May 2012, field technicians from the Gabon Parks Agency inventoried the plots using standard protocols. With these measurements, we predicted tree heights for all stems and estimated AGB. Using regression and model averaging techniques, we evaluated the relative role of soil, climate, and human disturbance on AGB. Finally, we tested the ability of Bastins model to predict AGB from large trees. Mean AGB from 1-ha permanent plots was 310.9 ± 141.5, and varied significantly across forest types, with primary and logged forests having significantly higher AGB than secondary forests ($p = 0.002$). National parks stored significantly greater AGB stocks than other land uses ($p = 0.015$). Regression models found variables related to human disturbance (forest type, distance to village, presence of trails) to be, in general, the strongest predictors of AGB, tree height, wood density, and diameter, but not tree density. Tree AGB can largely be predicted from the largest trees in forest plots, but models built for specific forest types fit significantly better than a single national model and predicted AGB with greater precision. The Gabon inventory demonstrates the enormous impact of humans on forest AGB and architecture, even in the second most forested tropical country with a near zero deforestation rate. While monitoring pristine forests is critical for understanding forest functioning, we underscore the importance of inventories that cover all forest types. These inventories have the potential to provide critical information for predicting the trajectory of disturbed forests and managing for carbon and other ecosystem services.

O15-09 – S15 *Ecosystem ecology of african forests*
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Future perspectives from historical data: addressing the data-gap in Central Africa

KATHRYN JEFFERY[1], LEE WHITE[1], EMMA BUSH[2], SAM MOORE[3], YADVINDER MALHI[3], SIMON LEWIS[4], EDMOND DIMOTO[1], JEAN-THOUSSAINT DIKANGADISSI[1], FIDELE EVOUNA ONDO[1], JOSUE EDZANG NDONG[1], CARL DITOUGOU[1], DAVID LEHMANN[2], KATHARINE ABERNETHY[2]
[1]Agence Nationale des Parcs Nationaux, Scientific Division, BP20379, LIbreville, Gabon
[2]University of Stirling, School of Natural Sciences, FK9 4LA, Stirling, UK
[3]University of Oxford, School of Geography and the Environment, OX1 3QY, Oxford, UK
[4]University of Leeds, School of Geography, LS2 9JT, Leeds, UK

Despite representing the second largest rainforest in the world, the Congo Basin has relatively few long-term data on forest ecology and climate compared to other tropical forested areas such as Amazonia. Although more studies have been initiated in recent years, the data gap is still a serious hindrance to the refinement and interpretation of regional climate and environmental models, meaning that the impacts of future climate change on central African forests are still largely unknown.
Committed to its role in international climate negotiations, Gabon has made significant contributions to bridge this gap, by setting up several initiatives to measure and monitor carbon stocks and ecological processes at a national scale. This approach is unusual in that it is government-led, conducted in collaboration with a network of world-leading scientists, using globally recognised methods.
One site of particular value is the Lopé region in Central Gabon. A climatically and anthropogenically driven landscape in a forest-savannah succession zone, it is ecologically rare for the region and has benefited from a permanent research presence for over 30 years. During this time several long-term ecological and environmental data-sets have been successfully built and maintained, and are now recognised as regionally unique.
Although the original research objectives for each of these data-sets have changed over time, their strength today lies in the combined and cumulative potential of the data to provide a much greater breadth of understanding of the links between environmental and ecosystem processes at different trophic scales than was ever anticipated by design, ultimately providing a unique contribution to climate science in the region and highlighting the importance of long-term investment in permanent research sites and in maintaining continuous data-sets over decades.
In this talk we present some recent data from the long-term forest ecology programme at Lopé and discuss its relevance in the context of regional and global climate science.

O15-10 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

Photosynthetic capacity dynamics along forest-savannah transition in West Africa

AGNE GVOZDEVAITE[1], IMMA OLIVERAS[1], TOMAS DOMINGUES[2], YADVINDER MALHI[1]
[1]University of Oxford, Environmental Change Institute, OX1 3QY, Oxford, UK
[2]Universidade de São Paulo, Biologia-FFCLRP, 14040901, Ribeirão Preto, Brazil

Background. Research into the 'tipping points' for forest-savanna transition zones related to ecosystem shifts require more attention as these ecotones are considered to be particularly sensitive to climate change. Here we aim to contribute towards a better understanding of the stability of the border between savannas and forests and to examine the key parameters in productivity of these ecotones – leaf photosynthetic capacity dynamics.
Method. We investigate the distribution and variation of photosynthetic traits in individual species and communities along savanna-forest transition zone in Ghana. Based on a novel photosynthetic capacity data acquisition method we explore these values in the context of foliar and soil nutrient concentrations, leaf morphology, phenology, successional guilds as well as different water-use or carbon-gain strategies. Finally, we compare our findings with the acquired results with ones from forest savanna transition in Brazil.
Result. Broadly, forest communities along this forest-savanna transition show no differences in photosynthetic capacity, which suggests utilization of different strategies by trees to maximize carbon gain. Additionally, not nitrogen but foliar phosphorus and calcium concentrations have a greater impact on limiting photosynthetic capacity of this ecotone. Interestingly, despite the obvious structural and biochemical differences between the forest-savanna transitions in Ghana and Brazil, we observed no significant dissimilarities when comparing photosynthetic traits for these ecosystems.
Discussion/conclusion. Our findings challenge understanding of forest-savanna dynamics and stability, especially, when discussing biochemical limitations to photosynthesis. We suggest that species present in this forest-savanna transition zone are very specialised and adapted to cope with different environmental conditions, typical feature of these gradients. Therefore, even small changes in temperature and precipitation could significantly alter the physiological behaviour and stability of the boundaries of these communities.

O15-11 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

Woody expansion in Africa's savannas: extent and drivers

EDWARD MITCHARD, CAROLINE LEHMANN
University of Edinburgh, School of GeoSciences, EH9 3FF, Edinburgh, UK

There is a widespread dialogue of deforestation, degradation and reducing ecosystem services in Africa's woodlands and savannas as human pressures on these ecosystems increase. While processes are occurring, simultaneously across Africa savanans woody cover is increasing, and in some places very rapidly.
Here we show results from a well-studied site in central Cameroon, Mbam Djerem National Park, where recently unearthed aerial photographs from the early 1950's allow for the forest history to be assessed over 60 years. Comparing these aerial photographs to modern-day Landsat imagery demonstrates that woody cover in and around this park has more than doubled over 60 years, a fact supported by a decade of field data.
Applying the same techniques results in the observation of changes of a similar nature and scale elsewhere across tropical Africa. For example, tree cover has increased in the savanna island of Lopé National Park in Gabon, around Budongo Forest Reserve in Uganda, and in the Eastern Arc Mountains of Kenya and Tanzania.
It is unclear what is driving these changes, and whether the same process acting in these dry tropical sites is also driving the well-known woody thickening occurring in southern Africa, the southern United States, and elsewhere. It is known that the atmospheric concentration of carbon dioxide has a significant effect on tree growth rates in these high temperature, often water limited, systems. This effect may be especially pronounced in young trees and resprouting individuals, thereby reducing the time to grow sufficiently tall between fire events to escape crown damage when the grass layer burns. However, the carbon dioxide concentration is not the only factor to vary over the past half century: herbivore densities, human influence, fire, rainfall, temperature and the timing of the seasons have all changed.
We cannot fully unpack the relative role of these changing atmospheric, climate and human pressures here. Instead we make a preliminary, observation-based study, by investigating using all available data the trends of all these processes across our study sites. The carbon dioxide trend is consistent and uniform: if no other trends (or combinations of trends) are found that could explain the consistent increase in vegetation in these sites, then that would strongly point towards increase atmospheric carbon dioxide as a key driver of vegetation change.

O15-12 – S15 *Ecosystem ecology of african forests*
Tuesday 21 June / 10:00-15:30 – Pasteur

Aboveground biomass production and carbon storage at different successional stages in an Afromontane tropical forest

BRIGITTE NYIRAMBANGUTSE[1], ETIENNE ZIBERA[2], ELIAS BIZURU[2], DONAT NSABIMANA[2], JOHAN UDDLING[1], HÅKAN PLEIJEL[1], GÖRAN WALLIN[1]
[1]University of Gothenburg, Biological and Environmental Sciences, 461, Gothenburg, Sweden
[2]University of Rwanda, Biology, 118, Butare, Rwanda

As a result of different types of disturbance, forests are a mixture of stands undergoing stages of ecological succession. Successional stage is likely to influence forest productivity and carbon storage, linking the degree of forest disturbance to the global carbon cycle and climate. Although, tropical montane forests are an important part of tropical forest ecosystems (c. 8% > altitude of 1000 m), there are still significant knowledge gaps regarding the productivity and storage of carbon (C) in these forests, and how it differ between secondary and primary stands.
This study examines biomass and production in secondary and primary stands in an Afromontane tropical rainforest using data from inventories of above ground biomass (AGB) parameters in 15 plots of 0.5 ha each. Successional stage was classified from the frequencies of pioneer and later successional species, number of big trees and the recruitment rate of new trees in each plot.
We found large heterogeneity in biomass distribution between and within plots, which partly was related to ecological succession patterns. Compared to the AGB reported in other mature tropical montane forests (average of 135 Mg C ha-1, assuming 50% C in wood; Spracklen & Righelato 2014) and to the late successional forest stands in this study (180 Mg C ha-1), the AGB in early successional forest stands was found to be considerably lower (108 Mg C ha-1). We found that an index of early-successional species (% biomass of pioneer species related to the total) correlated negatively, while the number of big trees (dbh > 40 cm) per area correlated positively with C stock. NPP and recruitment rate were higher in early-successional forest stands compared to late-successional forest stands due to faster growth rates of early-successional tree species. The above ground C stock was 66% higher in primary compared to secondary forest using species specific wood density and height-dbh relationship. If non-species specific parameters were used, the difference was reduced to 29%.
Our results show that tropical montane forests can contain large quantities of C, but that it is substantially reduced in forest stands regenerated after disturbances. The results emphasize the importance of using species-specific biomass parameters, such as direct height measurements, and wood density. Our study suggests that it is important to consider the successional stages when accounting the carbon balance of tropical montane forest ecosystems.

O16-01 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Ecosystem service bundling in the Panama Canal Watershed: Implications for land management in the humid steepland tropics

JEFFERSON HALL[1], MICHIEL VAN BREUGEL[2], FRED OGDEN[3]
[1]Smithsonian Tropical Research Institute, ForestGEO, N/A, Panama, Panama
[2]Yale-NUS, Biological Sciences, 138619, Singapore, Singapore
[3]University of Wyoming, Civil and Architectural Engineering, 82071, Laramie, USA

Background: Scientist, conservationists, and policy makers recognize the increased pressure placed on tropical forests to produce goods and services for a growing human population. Thus there has been an increased focus on understanding how goods and services are produced by forest ecosystems and how the flow of these "ecosystem services" will change with land use and climate change. Yet understanding biophysical processes is only part of the sustainability challenge as management entails choices by different constituencies with a stake in the.
The Agua Salud Project (ASP) is based in the Panama Canal Watershed and is a collaboration between local and international partners. The ASP project strives to address three overarching questions:
1) To what extent do seasonal tropical forests regulate water flows and how do flow characteristics and water quality change with land use?
2) What is the most efficient way to return degraded lands to productivity and maximize hydrological, carbon storage, and biodiversity-related services while at the same time providing economic opportunity for rural landholders?
3) How will global change impact ecosystem services and how can our understanding of changes in ecosystem function with land use inform mitigation and adaptation strategies to climate change?
Method: This talk will summarize talks from the other presentations in the session as they relate to land management and ecosystem services in the PCW and focus on linkages and tradeoffs between land use and biodiversity, carbon, and water related ecosystem services.
Result: Forests at the study site have been shown to regulate stream flows by moderating peak flows and maintain higher stream flows at the end of the dry season than a similarly sized agricultural mosaic. They sequester abundant carbon and have high biodiversity values. At five years carbon values of secondary forest (SF) > native monoculture plantations (NS) > teak plantations (TP) > pasture (P). Biodiversity values are SF > NS > TP > P. Stream flow data and social values will also be discussed.
Discussion: Mature forests provide a variety of ecosystem services that are important to society. As early as five years, and even on the low nutrient status soils of the Agua Salud site, data indicate that ecosystem services are being restored, be it at different rates. Thus social values will play an important role in determining which services to maximize and the different tradeoffs inherent to the choices.

O16-02 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Long-term Climate Patterns in the Panama Canal Region

STEVEN PATON[1], ROBERT STALLARD[2]
[1]Smithsonian Tropical Research Institute, Physical Monitoring, na, Panama, Panama
[2]Smithsonian Tropical Research Institute, Agua Salud, na, Panama, Panama

The Agua Salud Project has as a principal objective the characterization of the hydrology and biology of a complex rural landscape in the Panama Canal watershed. This combines bottom up and top down research approaches. For the former approach, we are undertaking detailed studies for the physical and biological characteristics and processes in roughly 1,000 ha of the Central Panama Canal watershed, including 14 nested small watersheds encompassing a range of land covers. For the latter approach, we are analyzing available data for the entire Panama Canal region. The spatial density of the data is less, 10m to 30m resolution for topography and vegetation mapped by remote sensing, approximately 60 precipitation stations and 8 water level gauges on large rivers. Most of these are operated by the Panama Canal Authority (ACP), but some are operated by the Smithsonian Tropical Research Institute (STRI). All stations collect hourly or better data. Unlike the bottom-up sites, many of these rain and river gauges have been operating continuously for long time periods, up to 130 years in some cases, spanning the complete clearing and partial regrowth the of some watersheds, five major El Niño / La Niña events, that in Panama correspond to droughts and wet periods, respectively. The data also span at least two cycles of the Atlantic Multi-decadal Oscillation (AMO which has cycles lasting 4 to 5 decades and may be responsible for much of the long-term oscillations in Central Panamanian rainfall patterns). At the same time, atmospheric carbon dioxide has increased from 300 ppmv, close to preindustrial concentrations, to over 400 ppmv, today.

O16-03 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Manifestations of Land Use Effects on Hydrology in the Panama Canal Watershed

OGDEN FRED, ROBERT STALLARD[4], ELI FENICHEL[2], JEFFERSON HALL[3], EDWARD KEMPEMA[1], MARIO BRETFELD[3], JIANTING ZHU[1], YANYAN CHENG[1], JASON REGINA[1]
[1]University of Wyoming, Civil & Architectural Engineering, 82071, Laramie, WY, US
[2]Yale University, School of Forestry and Environmental Studies, 06520, New Haven, CT, US
[3]Smithsonian Tropical Research Inst., Agua Salud Project, 20521, Panama City, PA
[4]US Geological Survey, Water Resources Program, 80304, Boulder, CO, US

Background: The Panama Canal Watershed represents a natural laboratory for studying the effects of land use change on water related ecosystem services. We have a Water, Sustainability and Climate (WSC) project funded by the US National Science Foundation that leverages Autoridad del Canal de Panama (ACP) data and Agua Salud Project infrastructure to evaluate the effects of land cover and land use history on hydrological behavior. Particularly, we are performing studies to develop predictive understanding leading to hydro-socio-economic models of tropical watersheds that specifically include land-use history. Our fundamental hypothesis is that land cover and use history manifests in terms of hydrological behavior owing to the influence of land use on biological activity in the upper soil column. Specifically our project seeks to answer the following questions:
1) How does land cover and land use history affect the creation/destruction of biologically-created preferential flow paths in tropical soils in mature forest, secondary forest of different ages, and disturbed agricultural lands?
2) How differently do each studied land cover/use behave hydrologically?
3) How much time is required for the hydrologic behaviors to respond to changes in land use?
4) What are the socio-economic benefits of PES in the humid tropical steeplands represented by the Panama Canal Watershed?
Method: This presentation describes the methods we are using in our studies.
Result: We have developed a high-resolution process-based hydrological simulation model that we call ADHydro, that is aimed at understanding land use effects on hydrological response. ADHydro is a quasi-3D model with 2-D overland flow and groundwater, coupled with 1-D infiltration and 1-D channel routing, that uses explicit finite volume flow solvers. ADHydro was developed from the beginning for execution in the supercomputing environment.
Discussion: The ADHydro model is allowing us to test and reject model formulation hypotheses that might explain the exact ways that land cover and land use history manifest as hydrological behavior. Plausible model formulations that include novel description of preferential flows allow testing of the effectiveness of PES in tropical low elevation humid steeplands such as the Panama Canal watershed.

O16-04 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Effects of plant-functional groups on biomass dynamics during early secondary forest succession

MICHIEL VAN BREUGEL[123], HAO RAN LAI[3], JEFFERSON S. HALL[2]
[1]Yale-NUS College,
[2]Smithsonian Tropical Research Institute,
[3]Department of Biological Sciences, National University of Singapore

Background: Today, more than half of the world's tropical forests consist of secondary forests, representing a huge carbon sequestration potential. Understanding and predicting secondary forest biomass dynamics are critical to understand their role in mitigating climate change, to improve global climate change models and to support intergovernmental and national discussions on climate-change related policies. However, within human-modified landscapes, biomass dynamics of successional forests is highly variable and the drivers of this uncertainty are still poorly understood.
Our research assesses the role of functional diversity on the biomass dynamics of early secondary forests in the Agua Salud landscape. We zoom in on the effects of lianas and nitrogen-fixing trees, two plant functional groups that are thought to play an important role in the dynamics of tropical secondary forests. Specifically, we test if (i) lianas have an adverse effect on the growth, survival and recruitment of trees, (ii) N2-fixing trees enhance the productivity of early secondary forests, (iii) the effects of both functional groups are mediated by soil fertility and (iv) these effects change with successional age.
Methods: Fifty-two secondary forest patches were randomly selected across the 15km^2 Agua Salud landscape. Previous land-use was a mix of pasture and cropland and successional age varied between 3 and 32 years. In 2009, two 0.1 ha plots were established in each patch in which all trees and lianas ≥ 1cm diameter are tagged, identified and re-measured annually. We used generalized linear mixed effect models to test for the effects of the relative abundance of lianas and N-fixers, soil fertility and interactions between soil variables and the relative abundance of both plant functional groups.
Results: Faster growth of N-fixers combined with a negative effect on the growth of non-fixers yielded a net neutral effect of N-fixer density on stand growth. Lianas did have a significantly negative effect on the growth of the largest, but not the smaller trees in our plots. Tree survival and recruitment were also affected by the relative densities of lianas, with some interesting interaction effects with soil variables. In our talk, we will discuss these in more detail.

ORAL PRESENTATIONS

O16-05 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Changes in soil microbial diversity across land use types in the Agua Salud

KRISTIN SALTONSTALL[1], BENJAMIN TURNER[1], MICHIEL VAN BREUGEL[2], JEFFERSON HALL[1]
[1]Smithsonian Institution, Smithsonian Tropical Research Institute, 34002, Panama City, Panama
[2]Yale-NUS College, Biology, 138610, Singapore, Singapore

Background: Forest recovery following abandonment of agricultural lands in the tropics depends on a variety of factors, including the surrounding vegetation communities, levels of soil degradation, and natural disturbance processes. Belowground microbial communities may also play an important role in the recovery of aboveground forest communities, as microbes may either enhance or postpone forest recovery.
Method: Soil samples were collected from three land-use types (pasture, young secondary and old secondary forests, n=12 in each) in the Agua Salud landscape near Colon, Panama. We investigated changes in soil bacterial and fungal communities across these land use types by sequencing 16s and ITS metagenomic libraries on an Illumina MiSeq. Nutrients and pH of each soil sample, as well as aboveground vegetation cover at each site were also analyzed. Molecular data were analysed using Qiime.
Results: Soil pH showed no significant differences across land use treatments. Acidobacteria, Proteobacteria, and Verrucomicrobia were the dominant bacterial phyla and Ascomycota, of the order Myriangiales, dominated the fungal community across all samples. At the community level, the bacteria and fungi of pasture soils were distinct from old secondary forest soils, with young secondary forest plots having communities representative of both pastures and older forest. As alpha-diversity of the aboveground vegetation increased, so did alpha-diversity of the microbial community, suggesting that higher plant diversity leads to higher belowground microbial diversity in these sites.
Discussion: The Agua Salud site is ideal for looking at the effect of land use and vegetation cover on soil microbial communities as it contains a mosaic of landscapes across an area with relatively homogeneous soils and other edaphic factors. Detailed analysis of soil properties and vegetation cover will enhance our understanding of the role that soil microbial communities may play in successional processes of tropical forests.

O16-06 – S16 *Understanding ecosystem services in the Panama canal watershed: implications for sustainable land management*
Tuesday 21 June / 16:00-17:30 – Pasteur

Reforestation with native and exotic timber species: Implications for bird diversity and community composition

SUNSHINE A. VAN BAEL[1, 2], RUBY ZAMBRANO[2, 3], JEFFERSON S. HALL[2]
[1]Tulane University, Ecology and Evolutionay Biology, 70118, New Orleans, USA
[2]Smithsonian, Tropical Research Institute, 0843–03092, Panama City, Panama
[3]Universidad de Panama, Biologia, 03092, Panama City, Panama

Background: While deforestation continues to be a threat to species diversity in the tropics, reforestation either by natural succession or human tree planting is also occurring. Very little is known about how bird communities respond to human-mediated reforestation schemes in tropical areas.
Methods: We surveyed bird communities of the Agua Salud experimental system in Central Panama to compare their abundance, richness and community composition. The habitats we compared were mature forest, young natural succession (fallow pastures), active cattle pastures, and reforestation areas with native and exotic timber species. Birds were surveyed two and seven years after tree planting in reforestation areas.
Results: Bird communities were most similar in forest and natural succession areas, and were distinct from bird communities in cattle pastures and reforestation areas. Reforestation areas that were closer to mature forest had a greater abundance of birds relative to areas further from forests. Plantations with exotic species led to bird communities that were similar to those in cattle pastures. Management of the understory in exotic species plantations resulted in different outcomes; where the understory was not cleared there was a higher diversity of habitats for a richer bird community.
Conclusions: Young reforestation areas support a low abundance of birds, but an increase in species abundance and diversity occurs rapidly. Developing a longer time series of bird surveys in the experimental Agua Salud system will clarify the biodiversity impacts of reforestation schemes with native versus exotic tree species.

O17-01 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Macroecological perspectives on palm diversity in a changing world

JENS-CHRISTIAN SVENNING
Aarhus University, Section for Ecoinformatics & Biodiversity, Department of Bioscience, 8000, Aarhus C, Denmark

Background: The palm family (Arecaeae) is a species-rich plant family that is globally distributed in Earth's warmer regions. It has a long history and was already diverse and widely distributed in the late Mesozoic. Earth has in the time of existence of the palms experienced strong global changes in its environment. These include strong climate changes on time scales from multi-million year climate trends to glacial-interglacial climatic oscillations at 10,000-100,000 year scales. In this talk, I will discuss how these paleoclimatic conditions and changes may still co-shape diversity patterns in palms.
Methods
In this presentation I will provide a synthesis of a broad range of macroecological studies of the role of paleoclimate in co-shaping, along with contemporary climate and other factors, palm diversity globally and regionally.
Results: Global and regional studies of palm diversity – covering not just species richness and species composition, but also phylogenetic and functional diversity – show clear imprints of paleoclimate. Notably, we find reduced palm diversity where the Quaternary glaciations have been particularly cold or dry. However, we also find imprints of deeper-time paleoclimate, likely representing both extinction-driven patterns and patterns driven by diversification and dispersal.
Discussion: Our macroecological findings show that the diversity of modern-day palm communities cannot solely be understood as an outcome of contemporary ecological processes, but also require consideration of historical factors such as paleoclimate. The long-term legacies of past changes in climate have important implications for what to expect in terms of dynamics in response to future human-driven climate change.

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O17-02 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Effects of "primatization" on the population dynamic of a palm tree that is vulnerable of extinction

RITA DE CASSIA QUITETE PORTELA
UFRJ, Ecologia, 22440040, Rio, Brazil

Changes caused by habitat fragmentation should lead to a decrease in the recruitment of seedlings of plant species, changing its population dynamics and thus jeopardize the persistence of populations. The high density of a predator should take the population of plant to a drastic reduction in its density. The hypothesis that reducing the habitat and increasing the abundance of a predator could lead to a negative growth rate of populations of a palm were tested in this study. The objective of this research is to compare long-term dynamics of populations of Euterpe edulis in a fragmented landscape of Atlantic Forest in the state of Rio de Janeiro, Brazil. Populations were marked in 2005, re-sampled from 2006 to 2015 each year in four forest fragments (19, 21, 57 and 2,600 ha). The predator (Capuchin monkey, Sapajus nigritus) is native and occurs only in the largest fragment and its population is superabundant. All palm individuals within the plots were marked and measured and re-measured and the new ones were marked and measured. Lefkovitch matrixs were built for each transition year and for each fragment. Lambda and elasticity were calculated. The behavior of the predator was filmed with ten cameras trap in the studied area. As a result of these ten years of study was found variation in population size in small fragments and a linear decrease in the largest fragment. There were 156 individuals with 11 adults in 2005 and 296 with 57 adults in 2015 in the smaller fragments and in the largest fragment there were 839 with 60 adults in 2005 and 154 with no adults in 2015. This decrease in the largest fragment is mainly due to mortality caused by the predator preying upon palm hearts, which ranged from 10 to 49 adult individuals death per year. According to the last three lambdas, it is estimated that the palm population in the largest fragment is decreasing 31%, 39% and 32% in each interval and the populations in the smaller fragments are stable. If nothing is done, the palm population located in the largest fragment will be extinct in the next years. The films showed that only one individual of predator kill an individual at a time by consuming its palm heart. According to these data, the effect of the overabundance of a native predator is most striking in the population dynamics than the reduction of habitat and could lead shortly the palm to extinction.

O17-03 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Population-level effects of hunting on seed dispersal, seed predation and population abundance in the Neotropical palm Attalea butyracea

MARCO VISSER[1], JOSEPH WRIGHT[2], HELENE MULLER-LANDAU[2], ANNIEKE BORST[1], PATRICK JANSEN[3]
[1]Radboud University, Plant Ecology, 6500, Nijmegen, The Netherlands
[2]Smithsinian Tropical Research Institute, NA, NA, Na, Panama
[3]Wageningen University, Resource Ecology, NA, Wageningen, The Netherlands

Seed dispersal not only determines the area in which plants can establish but also sets the spatial template for ensuing processes such as seed predation and future competition. Theoretically, therefore, dispersal has a direct influence on the population dynamics of plants. Hunting of seed dispersers and seed predators can in turn drastically alter population dynamics, potentially influencing plants abundance or competitive ability. We investigated the consequences of seed dispersal, seed predation and hunting for a neo-tropical palm Attalea butyracea. We show how seed movement is structured by competition for dispersers, how trophic interactions influence its seed predation and recruitment, and how hunting impacts all these processes. Finally, we present a population model, in which we follow individuals from seed to adult, to determine how processes affecting early life stages - as density dependence and hunting – ultimately affect the population growth rate.

O17-04 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Local and landscape scale determinants of gene dispersal of a tropical palm

CARVALHO CAROLINA[1], NICOLAS BARBIER[1], PIERRE PLOTON[5], LIBALAH MOSES[2], VINCENT DROISSART[1], NICOLAS TEXIER[4], PATRICK HOUDRY[3], BONAVENTURE SONKÉ[2], RAPHAEL PELISSIER[1], PIERRE COUTERON[1]
[1]IRD, UMR AMAP, 34398, Montpellier, France
[2]University of Yaounde I, Plant Systematic and Ecology Laboratory, B.P. 047, Yaoundé, Cameroon
[3]Airbus Defence and Space, -, 31402, Toulouse, France
[4]Université Libre de Bruxelles, Unité de recherche Evolution biologique et Ecologie, Herbarium et Bibliothèque de Botanique Africaine, B1050, Bruxelles, Belgique
[5]Institut des sciences et industries du vivant et de l'environnement, -, 34090, Montpellier, France

Seed dispersal is the first stage of plant recruitment and it is crucial to colonization, population connectivity and gene dispersal. Multiple factors can influence gene dispersal via seeds in human modified landscapes. Thus, investigating how seed and gene dispersal processes vary at multiple scales can unravel the mechanisms that allow the ecological maintenance and genetics of natural populations. Our aim was to determine how seed and gene dispersal of a bird-dispersed palm (Euterpe edulis) are influenced by local and landscape factors. Seeds were collected using 30 seed traps in every one of 10 landscapes along a gradient of forest cover in the Atlantic forest, and subsequently counted and measured The multilocus microsatellite genotypes were analyzed using metrics of genetic diversity: alpha, the genetic diversity of maternal genotypes in each seed deposition site; and gamma, the total diversity of maternal genotypes in a forested area. We modeled the number of seeds and diversity metrics as a function of habitat characteristics that are presumed to affect frugivory and space use by frugivorous birds; landscape structural features; and composition of seed disperser assemblages. We found that there were more seeds in deposition sites located amongst more fruiting palms and in forest remnants with more pristine bird assemblages than in sites with fewer palms and in defaunated landscapes. Moreover, in defaunated sites, the farther was the nearest fruiting palm, the smaller was the dispersed seed. The local alpha diversity of maternal genotypes was positively related to the number of fruiting adults in defaunated sites, but not in non-defaunated landscapes. Overall diversity (gamma), however, did not vary across landscapes. Although we did not find evidence that overall gamma diversity is affected by landscape and bird assemblage characteristics; density and proximity of fruiting palms did influence the spatial and genetic distribution of seeds; relations that were more pronounced in landscapes with impoverished bird assemblages. Because most of tropical tree species rely on seed dispersal by vertebrates, these results fostered our understanding about the mechanisms that alter the seed and gene dispersal processes in altered environments.

O17-05 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Where do all the (dioecious) flowers go? Diversity and distribution of breeding systems in Neotropical palms

SIMON QUEENBOROUGH[1], HENRIK BALSLEV[2]
[1]Yale University, School Of Forestry & Environmental Studies, Ct 06511, New Haven, USA
[2]Aarhus Univeristy, Department of Bioscience, Dk-8000, Aarhus, Denmark

Background: Dioecy, whereby male and female flowers occur on separate individuals, is an uncommon yet widespread breeding system in plants: Only 6% of all angiosperms are dioecious, yet the system is found in over 50% of families. Despite increasing knowledge of the evolutionary distribution of breeding systems, much less is known about the ecological distribution---where do most dioecious species occur? In what habitats are they most prevalent? And what drives variation in breeding system at the individual and species levels?
Methods: Palm trees are a ubiquitous component of tropical forests, especially in the Americas. The family is ideal for the study of breeding systems because dioecious, monoecious and hermaphrodite species are found within the family and the phylogeny is well-resolved. We make use of a large-scale transect dataset of palm trees throughout the Neotropics. We map breeding system on each individual palm in the data and examine where most dioecious species and individuals are found and the ecological and abiotic drivers of this variation.
results: Most palms are monoecious, and this result was consistent across individuals and species present in the transects, although the incidence of dioecy (>10%) was higher than angiosperms in general. Most transects had fewer than 50% dioecious species, but a number were wholly composed of dioecious palms. Within South America, there was a significant latitudinal trend, with fewer dioecious species further from the equator. However, many transects in Mexico and Belize had high incidence of dioecy, disrupting this trend.
conclusion: Breeding system has profound implications for the ecology and evolution of plants. Understanding where species of different breeding system occur and why will help with forest conservation, restoration, and the maintenance of functioning tropical ecosystems.

O17-06 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Spatial patterns of seed predation by a specialized invertebrate

NOELLE G. BECKMAN[1], CAROL X. GARZON-LOPEZ[2], HELENE MULLER-LANDAU[3], PATRICK JANSEN[3], S. JOSEPH WRIGHT[3]
[1]University of Maryland, College Park, National Socio-Environmental Synthesis Center, 21401, Annapolis, USA
[2]Université de Picardie Jules Verne, Ecologie et Dynamiques des Systèmes Anthropisés, 8000, Amiens, France
[3]Smithsonian Institute, Smithsonian Tropical Research Institute, 0843-03092, Panamá, Panamá

Specialized natural enemies promote coexistence through population-level negative density-dependence. Modeling studies have shown that emergent seedling patterns depend on the interacting patterns of seed dispersal and seed predation. Patterns of predation, in turn, depend on the movement ability of the predator, the distance between seeds and parent trees, the local density of seeds, and the density of fruiting adults in a population. The spatial patterns of seed predation are rarely studied in natural systems. To our knowledge, this is one of the first studies to describe the spatial pattern of seed predation and analyze seed predation at the population-level.
We conducted a large-scale study with the palm Attalea butyraceae on Barro Colorado Island (BCI) in Central Panama. The main invertebrate seed predator of A. butyracea on BCI is the specialist bruchid Speciomerus giganteus. We set out individual seeds of A. butyracea every 100 m at trail markers along the BCI trail system and below a subset of palm crowns (621 seeds total). A. butyracea crowns were mapped using aerial images to assess crown size, location, and density of palms. We conducted a ground census within 25 meters of each trail marker to obtain finer scale resolution of locations. Seeds were monitored for bruchid eggs after 8 days, collected from the field after one year, and incubated for ca. one year to quantify seed predation (larvae, exit holes, adults) and seed fate. Using maximum likelihood methods, we fit a set of candidate models to describe spatial patterns of bruchid oviposition based on nearest neighbor distances between trail markers and palms, bruchid fecundity based on crown area (measured from aerial images), and an error term. We selected the best-fit model using Akaike Information Criterion.
Preliminary analyses suggest that beetles move from relatively short to long distances from reproductive adults to oviposit eggs. Twenty-five percent of seeds within 15 m of reproductive adults had at least one beetle, compared with 25% of seeds within 15-50 m from adults, and 12.5% of seeds >50 m from adults. Distance to nearest adult reduced seed survival.
Relatively little is known about the movement ability and oviposition patterns of bruchid beetles in natural systems. This information is necessary for parameterizing models of insect seed predation to gain a better understanding of how spatial patterns of seed and insect dispersal affect plant coexistence.

O17-07 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Keeping it in the family: Genetic implications of limited seed dispersal for Coco de Mer, the largest-seeded plant in the world

EMMA J. MORGAN[1], CHRISTOPER N. KAISER-BUNBURY[2], PETER J. EDWARDS[3], FRAUKE FLEISCHER-DOGLEY[4], CHRIS J. KETTLE[1]
[1]ETH Zürich, USYS-ITES, 8092, Zürich, Switzerland
[2]TU Darmstadt, Department of Biology, 64287, Darmstadt, Germany
[3]ETH, Singapore-ETH Centre, 138602, Singapore, Singapore
[4]Seychelles Islands Foundation, SIF, PO Box 853, Mahé, Seychelles

Background: The extraordinary Lodoicea maldivica (Coco de Mer) is an endangered, dioecious palm found on the granitic islands of Praslin and Curieuse in the Seychelles. This giant island endemic produces seeds weighing an average of 10 kg, enclosed in a fruit weighing around 20 kg. Consequently, this remarkable palm lacks any means of dispersal other than gravity. The species has suffered extensive alteration of habitat and is heavily exploited due to over-harvesting of nuts. Despite its ecological, economical and cultural significance, the reproductive ecology and genetic structure of Lodoicea remain poorly understood.
Methods: Using 12 microsatellite loci, and a range of genetic approaches, we assess realised seed dispersal and its effect on fine-scale spatial genetic structure (FSGS) in Lodoicea. We include all of the remaining natural populations, and a range of age cohorts, which have been subjected to differential levels of fragmentation. We also measure genetic diversity, inbreeding and genetic differentiation among these different groups.
Results: We quantify extremely limited seed dispersal distances in Lodoicea (mean: 8.7 ± 0.7 m), with topography having a significant effect. FSGS correlated with seed dispersal distances, and was intense in all populations, and especially so in younger age cohorts compared to adults. Genetic diversity was uniform across all groups, yet inbreeding was consistently high, despite varying degrees of habitat disturbance. Pairs of male and female trees up to 10 m apart were highly related to each other ($F = 0.07$).
Discussion: Lodoicea provides a powerful study system for investigating the long-term effects of habitat fragmentation in a poorly-dispersing tropical plant species. We discuss the genetic consequences of restricted seed dispersal and high relatedness of neighbouring palms. We suggest that trade-offs associated with limited dispersal, maternal resource provisioning of progeny and inbreeding avoidance may have been important in shaping the demography of this extraordinary monodominant palm species. Our results are of high conservation importance and will enable us to develop guidelines for the sustainable management of this important keystone species.

O17-08 – S17 *Palm ecology in a changing world*
Tuesday 21 June / 10:00-12:00 – Einstein

Drought-driven decline of palm hyperdominance in an Amazonian forest

THAISE EMILIO
EMILIO THAISE[1, 2], CASTILHO CAROLINA[3], TOLEDO JOSE JULIO[4], COSTA FLAVIA[1], POORTER LOURENS[5]
[1]Instituto Nacional de Pesquisas da Amazonia (Inpa) – Coordenação de Biodiversidade
[2]Royal Botanic Gardens Kew - Comparative Plant & Fungal Biology
[3]Empresa Brasileira de Agropecuaria (Embrapa) – Embrapa Solos/UEP Recife
[4]Universidade Federal do Amapa - Programa de Pós-Graduação em Biodiversidade Tropical
[5]Wageningen University - Forest Ecology and Management Group

In Amazonian forests, six out of ten most "hyperdominant" arborescent species are palms. It is unclear why palms are so abundant, but one of the reasons could be their unique hydraulic structure. Palm vascular architecture is based on wide xylem vessels that make palms efficient in water transport but more vulnerable to drought-induced cavitation. This would make palms more successful than trees in wet habitats and years but not in dry habitats and years. Here, we show for an Amazonian rainforest that palms have higher mortality rates and similar recruitment rates as trees, but more negative population growth than trees after drier years. Palms also have a higher probability to die standing, suggesting that palms are more sensitive to drought. The current decline in palm abundance points to important climate-driven changes in the hyperdominance structure of the Amazon with potentially large consequences for ecosystem functioning.

O18-01 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Using molecular tools to model cascades of extinctions under projected global warming: plant, insect herbivores and phoretic mite interactions along a tropical elevational gradient

CARLOS GARCIA-ROBLEDO[1], W. JOHN KRESS[1], TERRY L. ERWIN[2]
[1]Smithsonian Institution, Botany, 20650, Washington D.C., United States of America
[2]Smithsonian Institution, Entomology, 20650, Washington D.C., United States of America

Background: One overlooked driver of biodiversity loss is co-extinction: the loss of species as a result of the extinction of species upon which they depend. Global warming is expected to increase extinction rates in elevational gradients. However, the effects of climate change on biodiversity loss through co-extinctions at different elevations remain unknown. Two groups of organisms highly susceptible to co-extinctions are insect herbivores and phoretic mites, a guild of mites that hitchhike on insect herbivores to colonize their host plants.
Methods: This project evaluates how host plant extinctions will generate cascades of associated insect herbivore and phoretic mite co-extinctions under projected climate change in a tropical elevational gradient (Barva transect, Costa Rica). We used plants from the order Zingiberales, insect herbivores (Cephaloleia beetles) and phoretic mites, as our study system. Combining field observations and molecular tools, we are compiling the following datasets to model cascades of co-extinctions in complex plant-arthropod networks under projected global warming: (1) elevational distributions of plants, insect herbivores and phoretic mites (2) identification of insect herbivore diets using DNA extracted from gut contents (3) identification of insect herbivore - phoretic mite associations using DNA barcodes. Here we explore the following questions: (1) Are specialized herbivores and mites more vulnerable to coextinctions than generalists? and (2) Are insect herbivores and their associated phoretic mites more susceptible to extinctions at higher elevations?
Results: By combining field records and interaction networks reconstructed using DNA markers, we conclude that diet breadths of insect herbivores shrink with increasing elevation. In contrast, preliminary results suggest that low-elevation phoretic mites are specialized on one or a few insect herbivores, but high-elevation mite species are more generalists. Future studies will determine if these differences in the patterns of specializations will determine differences in coextincition rates of insects and mutualistc and parasitic phoretic mites.

O18-02 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Insect herbivores and herbivory across the Stability of Altered Forest Ecosystems (SAFE) gradient of habitat modification in Borneo

SARAH MAUNSELL[1], JANE HARDWICK[1], LOIS KINNEEN[1], TOM FAYLE[2], KALSUM YUSAH[3], ALISON SHAPCOTT[4], NIGEL STORK[1], ROGER KITCHING[1]
[1]Griffith University, Environmental Futures Research Institute, 4111, Brisbane, Australia
[2]Czech Academy of Sciences, Department of Ecology and Conservation Biology, 37011, Ceske Budejovice, Czech Republic
[3]Universiti Malaysia Sabah, Institute for Tropical Biology and Conservation, 88558, Kota Kinabalu, Malaysia
[4]University of the Sunshine Coast, Genecology Research Center, 4558, Maroochydore, Australia

Background: Deforestation in south-east Asia has largely been driven by logging and the expansion of oil palm plantations. The SAFE (Stability of Altered Forest Ecosystems) Project, based in Malaysian Borneo, is a large-scale fragmentation experiment that was established in response to the challenge of understanding the ecological consequences of landscape conversion. Like the plant communities with which they are associated, herbivorous insects are highly diverse in tropical ecosystems. Due to their dependence on just a few host species, specialist herbivores are expected to be more vulnerable to habitat change than generalists.
Methods: As part of the wider SAFE Project, we investigated how two groups of insect-herbivores that vary in their degree of host specificity respond to habitat modification. Moths and Orthoptera (grasshoppers and crickets) were sampled at 86 points across old growth forest, logged forest, logged and fragmented forest and oil palm plantation. Samples were sorted to species and DNA barcoding was used to confirm species identifications. Barcoding is also being used to determine the host plants of orthopterans, which are supposedly generalist herbivores. We also established an herbivory experiment whereby two tree species (Dipterocarpaceae) were planted in both fragmented and continuous forest. Leaves were scanned in situ on three occasions and leaf loss was measured.
Results: Over 10000 moths belonging to over 700 species and 2000 orthopterans belonging to over 100 species were sampled. We present results showing how the structure of moth and orthopteran communities change across the habitat modification gradient. Not surprisingly, we found that communities occurring in oil palm plantations were distinct from those occurring in logged, logged and fragmented and old growth forests. We also investigate whether or not communities in logged habitats are subsets of those from old growth forest. Preliminary results of orthopteran diet are also presented. Finally, we compare rates of herbivory in recently fragmented forests to that occurring in continuous forests.
Conclusions: Our results enhance our understanding of the effects of one of the most pervasive environmental modifications currently affecting the ecological function of forests in south-east Asia. Our findings indicate how resilient or vulnerable different groups of herbivores are to logging and fragmentation and how the process of herbivory is impacted by fragmentation.

O18-03 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Bees, wasps and their antagonists along an elevational gradient at Mount Kilimanjaro: effects of climate and land use

ANTONIA MAYR, MARCELL PETERS, INGOLF STEFFAN-DEWENTER
University of Wuerzburg, Department of Animal Ecology and Tropical Biology, 97074, Wuerzburg, Germany

Background: While patterns of species richness along climate and land use gradients received high attention in the ecological literature, the response of complex ecological interaction networks to these key drivers remained little understood. Using trap-nests as a model system, we investigated the combined effects of climatic changes and land-use intensification on the multitrophic interaction networks of plants, bees, wasps and their parasitoids along an elevational gradient on Mt. Kilimanjaro, Tanzania.
Methods: Trap nests were installed on ground and canopy level on a total of 26 study sites across natural and agricultural habitats. Trap nests were checked monthly over more than one year for hatching bees, wasps and their antagonists while floral resources, climate and other potential influencing variables were continuously monitored.
Results: First results showed highest trap-nesting bee and wasp occurrence in lowland savanna ecosystems and a monotonous decrease of nest numbers with elevation. Nest-building activities appeared to be strongly connected to rain and flower availability, especially in the arid savannah ecosystems.
Conclusion: In this talk we will show how land use and climate influences floral resource availability, the reproduction of bees, wasps and their parasitism by parasitoids.

O18-04 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Barriers to plant migrations in the Anthropocene: Changes in mammal seed dispersal along an elevational gradient

ERIN KUPREWICZ, CARLOS GARCIA-ROBLEDO
Smithsonian Institution, Department of Botany, National Museum of Natural History, 20560, Washington, USA

Human-induced environmental changes are so pervasive that we now informally refer to our current geologic period as the Anthropocene, the Age of Humans. One region where these effects are most prominent is the tropics, where seed dispersal by mammals is common and, sometimes, essential. Plants rely on seed dispersers to colonize new environments they may face under climate change. In a warming world, tropical biota will mostly rely on elevational migrations to locate habitats that fit their ecological and physical requirements. The objectives of our study are to determine (1) if upslope barriers currently exist to prevent plant range expansions, (2) if seed dispersers can move seeds into novel habitats to track or outpace global warming, and (3) how elevational changes affect seedling survival.
In this study, we are investigating if pre- and post-dispersal barriers exist to delimit the ranges of plants on a tropical mountain in the Los Tuxtlas Biosphere Reserve, Mexico. Using transplant experiments of natural and artificial seeds and seedlings at two elevations (lowland forest = 0 m asl and pre-montane forest = 1200 m asl), we are assessing seed dispersal/predation and seedling survival in native and novel habitats.
Fates of artificial seeds were not affected by size at either elevation, but artificial seeds had higher survival in the lowland forest compared to pre-montane forest at 1200 m, where terrestrial rodents consumed most seeds. Astrocaryum mexicanum seeds were preferentially removed and eaten by squirrels and mice in lowland forests, but not in highland forests. Nectandra ambigens seeds and seedlings suffered high mortality via rodent seed predation in the highlands compared to the lowlands.
The results of this study have implications for understanding plant range expansions/contractions in a changing world. Some species do not face barriers to upslope migration (A. mexicanum) and may be able to colonize this habitat to outpace global warming. However other species (N. ambigens) face strong, pre-existing biotic barriers to survival at higher elevations. If they are unable to colonize novel highland habitats as biomes shift upward, these barriers will prevent successful elevational migration, resulting in lowland biotic attrition. Altered plant-animal interactions in the Anthropocene, especially seed dispersal and predation, will play major roles in redefining tropical plant communities as the world warms.

O18-05 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Scatter-hoarding dependence of Astrocaryum sciophilum for seedling recruitment: perspectives for defaunated scenarios

CAROLINE MARQUES DRACXLER, PIERRE-MICHEL FORGET
National Museum of Natural History, Adaptative Mechanisms & Evolution, 91800, Paris, France

Scatter-hoarding rodents play an important role for large-seeded palm regeneration. By caching palm seeds for later consumption, scatter-hoarding rodents remove seeds from the proximity of parents, dispersing the seeds along the forest and disfavoring invertebrate infestation such as bruchid seed predation. In this study we investigate the contribution of scatter-hoarding rodents to seedling recruitment (up to 4-yr seedlings) of the masting palm species Astrocaryum sciophilum in the Amazon of French Guiana. Due to the high rates of bruchid seed predation, we expected that A. sciophilum would be highly dependent on the activity of scatter-hoarding rodents for seedling recruitment. We evaluated quantitative and qualitative aspects of A. sciophilum seedling recruitment along 14 plots established in a fully preserved forest (Nouragues Research Station) and in a disturbed forest (Oyapock forest), and we checked whether a seedling was originated from scatter-hoarded seeds. We expected higher seedling recruitment rates in the intact forest, as well as a higher proportion of seedlings arising from cached seeds. Seedling recruitment rates were two times higher in the intact forest than in the disturbed forest. When checking for scatter-hoarding contribution to seedling recruitment in the intact forest, we found that 88% of seedlings were originated from cached seeds, while 94% of seedlings found at the disturbed forest emerged from cached seeds. Of those seedlings, 17% of cached seeds associated to seedlings were recovered by rodents at the intact forest, while 42% of cached seeds were recovered by rodents at the disturbed forest. Our results show that regeneration of A. sciophilum is not only dependent on seed dispersal events but also highly dependent on seed caching by scatter-hoarding rodents. The higher seedling recruitment in the intact forest can be explained by the high frequency of interaction with scatter-hoarding rodents, as well by the lower rate of recovering of cached seeds. Despite the lower seedling recruitment at the disturbed forest, regeneration is maintained by scatter-hoarding activity. Our study indicates that A. sciophilum regeneration can be strongly affected by the loss of scatter-hoarding rodents in tropical forests. The high dependence on scatter-hoarding activity for regeneration also reinforces the evolutionary aspect of rodent-palm interactions and the vulnerability of large-seeded palms in scenarios of increasing defaunation.

O18-06 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Frugivores bias seed-adult tree associations through nonrandom seed dispersal

ONJA RAZAFINDRATSIMA, AMY DUNHAM
Rice University, Department of BioSciences, 77005, Houston, United States of America

Background: Frugivores are the main seed dispersers in many ecosystems, such that behaviorally driven, nonrandom patterns of seed dispersal are a common process; but patterns are poorly understood. Characterizing these patterns may be essential for understanding spatial organization of fruiting trees and drivers of seed-dispersal limitation in biodiverse forests.
Method: We studied resulting spatial associations between dispersed seeds and adult tree neighbors in a diverse rainforest in Madagascar, using a temporal and phylogenetic approach.
Result: Data show that by using fruiting trees as seed-dispersal foci, frugivores bias seed dispersal under conspecific adults and under heterospecific trees that share dispersers and fruiting time with the dispersed species. Frugivore-mediated seed dispersal also resulted in nonrandom phylogenetic associations of dispersed seeds with their nearest adult neighbors, in 9 out of the 16 months of our study. However, these nonrandom phylogenetic associations fluctuated unpredictably over time, ranging from clustered to overdispersed. The spatial and phylogenetic template of dispersal did not translate to similar patterns of association in adult tree neighborhoods, suggesting the importance of post-dispersal processes in structuring plant communities.
Conclusion: Results suggest that frugivore-mediated seed dispersal is important for structuring early stages of plant-plant associations, setting the template for post-dispersal processes that influence ultimate patterns of plant recruitment. Importantly, if biased patterns of dispersal are common in other systems, frugivores may promote tree coexistence in biodiverse forests by limiting the frequency and diversity of heterospecific interactions of seeds they disperse.

O18-07 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Avian seed dispersers affect the structure of succesional forests in non-random way

TOMAS CARLO[1], SUANN YANG[2], AARON GONZALEZ-CASTRO[1]
[1]Penn State University, Biology, 16802, State College, USA
[2]Presbyterian, Biology, 29325, Clinton, USA

Tropical forests harbor the largest share of terrestrial biodiversity. Remarkably, today's tropical forest cover is dominated by forests that have regenerated in abandoned agricultural or pasture lands. Because secondary successional forests are major features of tropical landscapes, it is critical to know what factors shape their formation. For plants, seed dispersal is the critical first step of community assembly, particularly for tropical forests undergoing secondary succession. Frugivorous animals such as birds are responsible for a large share of the seed dispersal processes in tropical forests because most tropical tree and shrub species bear fruit and seeds adapted for avian consumption and dispersal. We hypothesized that the assemblage of birds that consume fruit and disperse seeds provides a mechanism that promotes the maintenance of plant species diversity. Through their foraging preferences and movement behavior, the community of avian frugivores may disproportionately disperse fruits of plant species compared to the abundance and distribution of these species. To test this hypothesis, we conducted a seed addition experiment in an agricultural pasture containing tropical forest fragments in northwest Puerto Rico. We quantified how the relative abundance of seeds within available fruits in the community, as estimated at two spatial scales, controls local patterns of seed dispersal and plant recruitment. We found that the avian disperser community shaped the resultant plant community in nonrandom ways. Birds significantly increased the diversity of early successional plant communities relative to species pools within 50 m from experimental plots. Communities generated by natural avian seed dispersal were as diverse as those communities produced by experimental seed additions based on the species pool available at a scale of several square kilometers. The plant communities formed via avian dispersal experienced the smallest post-dispersal losses of diversity, thereby maintaining (and sometimes gaining) diversity relative to the other seed addition treatments. Birds may diversify regenerating tropical forests by not only delivering more species to a site than are locally available, but also bringing species that locally adapted to survive at the site. Our study suggests that the network of mutualistic interactions in tropical forests can indeed maintain biological diversity, starting from the very early stages of community formation.

O18-08 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Flying foxes in durian orchards – raiders or potential pollinators?

SHEEMA ABDUL AZIZ[1, 2, 3], GOPALASAMY REUBEN CLEMENTS[1, 4], TUANJIT SRITONGCHUAY[5]
KIM MCCONKEY[3], SAIFFUL PATHIL[6], MUHAMMAD NUR HAFIZI ABU YAZID[6], AHIMSA CAMPOS-ARCEIZ[3],
PIERRE-MICHEL FORGET[2], SARA BUMRUNGSRI[5]
[1]Muséum National d'Histoire Naturelle, Département Écologie et Gestion de la Biodiversité, 91800, Brunoy, France
[2]University of Nottingham Malaysia Campus, School of Geography, 43500, Semenyih, Malaysia
[3]Rimba, Project Pteropus, 43650, Bandar Baru Bangi, Malaysia
[4]Universiti Malaysia Terengganu, Kenyir Research Institute, 21030, Kuala Terengganu, Malaysia
[5]Prince of Songkla University, Department of Biology, 90112, Hat Yai, Thailand
[6]Tree Climbers Malaysia, Xtree Resources, 41300, Shah Alam, Malaysia

Flying foxes (Pteropus spp.) are known to play important ecological roles through both seed dispersal and pollination, particularly on tropical islands. Yet they are also hunted as food and medicine, and persecuted by farmers for being crop raiders in orchards and plantations. Due to the paucity of data on this issue, there is an urgent need to address this conflict by conducting research that will inform appropriate conservation interventions. In Southeast Asia, the durian (Durio zibethinus) is a culturally and economically important fruit crop. Flying foxes and the Cave Nectar Bat (Eonycteris spelaea) are known to visit orchards to feed on the flowers, leading to a perception among farmers that bats cause damage and negatively impact fruit production. While pollination experiments have shown that E. spelaea is actually a major pollinator for durian, the role of flying foxes is still poorly understood, and requires further elucidation. Here, we conducted ecological and social surveys to determine whether the Island Flying Fox (P. hypomelanus) is a raider or a possible pollinator of durian trees on Tioman Island, Peninsular Malaysia. We conducted a questionnaire survey in one village containing durian orchards, yielding 119 respondents. 33% of these people owned durian trees. We asked questions to determine whether flying foxes were perceived to be pollinators or raiders. Only 6% of all respondents (and 10% of durian growers) stated that flying foxes feed on durian flowers, with 17% of people agreeing that flying foxes facilitate pollination, but only one person specifically citing pollination of durian flowers. 18% of durian growers stated that flying foxes raided their durian trees (including fruit), causing damage. To test the validity of their perceptions, we deployed 19 paired camera- and video-traps on four flowering durian trees in one durian orchard to identify the main animal visitors, as well as their feeding behaviour. Our preliminary results indicate at least seven species of animals, including P. hypomelanus. Most importantly, we now have the first known video footage of free-ranging P. hypomelanus feeding on nectar of durian flowers. These findings have important implications for the role of flying foxes in pollinating durian, and can help devise awareness and outreach efforts for flying fox conservation in Southeast Asia.

O18-09 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Influence of local and landscape factors on flower visiting bees within Atlantic Forest landscapes

DANILO BOSCOLO[1], JULIANA TAKATA[1], PAOLA MANDETTA TOKUMOTO[2], PATRICIA ALVES FERREIRA[1]
[1]FFCLRP-USP, Biology, 14040-901, Ribeirão Preto, Brazil
[2]ICAQF-UNIFESP, Biosciences, 09972-270, Diadema, Brazil

Pollinators, mostly bees, are responsible for the maintenance of plant reproduction in natural and anthropic ecosystems. However, bees are very sensitive to forest loss and fragmentation. This disturbance can lead to decreased pollinator richness and visitation frequencies. On the other hand, the structural diversity and abundance of plant species in the environment may alter visitation rates and bees visiting behaviour. The aim of this study was to understand how surrounding landscape structure (amount of habitat and isolation) and local characteristics of forest patches influence floral visiting bees' abundance and species richness. In landscapes with more forest, we expected higher pollinators richness. In patches with less resources availability, we expected lower abundance of pollinators. Also, patches with better vegetation structure, such as reduced canopy opening, high trees with high diameter at breast height (DBH) can offer best conditions for bee community. We studied 27 forest patches in the Atlantic Rainforest region in São Paulo – Brazil. Inside each forest patch we delimited a hexagon plot with 25m side. Floral visitor bees were collected actively at all floral plant species. We measured undergrowth density, dead trunk quantity (nesting resources), tree height, canopy opening and plant richness (food resource). Preliminary results showed that floral richness is directly proportional to bee richness ($p<0,05$; R^2 =0,53569) and abundance ($p<0,05$; R^2 = 0,43858). Principal Components Analysis (PCA) explained 36,94% of vegetation structure, indicating that canopy cover had more influence than other variables. This highlight the importance of light penetration to forest patches. Additionally, we found positive relations between bee richness and the surrounding amount of forest. Our results highlight the importance of the maintenance of diversified floral species in fragmented landscapes that are under pressure of forest loss, once a greater available diversity of floral resources can lead to more diverse bee community. Also, higher resource accessibility is provided by landscapes with more forests, since it leads to better habitat connectivity. This may aid pollinators to move between forest patches, increasing accessibility to floral resources and, consequently, providing better landscape wide pollination services. Proper pollination management should seek to increase both landscape connectivity and floral availability within patches.

O18-10 – S18 *Tropical plant-animal interactions in the anthropocene*
Tuesday 21 June / 14:30-17:30 – Einstein

Predicting changes to the food webs of African large herbivores in the Anthropocene

TYLER KARTZINEL, ROBERT PRINGLE
Princeton University, Department of Ecology and Evolutionary Biology, 08544, Princeton, USA

Background: Environmental changes during the Anthropocene will reconfigure African savanna food webs, which are among the last to support intact assemblages of large mammalian herbivores (LMH). There is uncertainty about the future resilience of these food webs due to increasing growth of human and livestock populations, severe drought and increasing temperatures, and the extirpation of wildlife. Current efforts to predict and mitigate the consequences of these changes for ecosystem services—such as income from ecotourism, livestock productivity, and habitat stability—are underdeveloped due to data that lack sufficient taxonomic and spatiotemporal resolution.
Methods: We reconstructed plant-herbivore interactions with species-level precision in a biodiverse Kenyan savanna across multiple seasons, habitats, and climates using DNA metabarcoding. We used ~1000 dung samples to reconstruct the diets of 23 LMH species—18 wild and 5 domestic—that range in size from 5-kg dik-dik to 5000-kg elephant.
Results: These LMH species exhibited broad diets, with ~150 plant species and >30 plant families represented in the food web. Under arid conditions, LMH species exhibit striking shifts in dietary composition, especially in terms of the degree to which they specialize on particular plant types. These dietary shifts induce changes in the level of dietary niche partitioning between livestock and wildlife on shared rangelands.
Conclusions: Drought and drier climates reconfigure plant-herbivore interactions that involve wild and domestic herbivores in East African savanna. We predict that the ability of specific plant lineages to withstand herbivory by an increasingly broad functional diversity of LMH species under these conditions will underpin the future fragility of the food web.

O19-01 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Ectomycorrhizal fungal diversity: comparing techniques for enumeration at Pasoh Forest Reserve  (Malaysia)

FRANCIS Q. BREARLEY[1], JÓZSEF GEML[2], KRISTA L. MCGUIRE[3], LEHO TEDERSOO[4], PATAHAYAH BINTI MANSOR[5], SU SEE LEE[5]
[1]Manchester Metropolitan University, School of Science and the Environment, M1 5GD, Manchester, UK
[2]Naturalis Biodiversity Centre, PO Box 9517, 2300 RA, Leiden, The Netherlands
[3]Barnard College, Columbia University, Department of Biological Sciences, NY 10027, New York, USA
[4]University of Tartu, Natural History Museum, 51014, Tartu, Estonia
[5]Forest Research Institute of Malaysia, Forest Health and Conservation, Biodiversity Division, 52109, Kepong, Malaysia

Background: Dipterocarps form the major floristic component of most of the forests of South-east Asia and form ectomycorrhizal (EcM) associations, in contrast to most other tropical tree families. It is important to understand the diversity and dynamics of EcM fungi in this region and make comparative studies with boreo-temperate forests.
Methods: Pasoh Forest Reserve, in central Peninsular Malaysia, is probably the best-studied site for EcM fungi in the Palaeotropics. We describe here the fungal communities from fruit body surveys, EcM root tip morphotyping/sequencing and three next-generation sequencing surveys of soil samples (Illumina, Ion Torrent and 454).
Results: The different approaches revealed a somewhat different view of the EcM community but overall, showed the importance of Thelephoraceae, Russulaceae and Boletaceae as major EcM fungi in this forest. The effect of historic logging (50 years previously) can still be seen on the fungal communities. A preliminary assessment of the role of different fungal species for dipterocarp nitrogen nutrition was undertaken using stable nitrogen isotopes.
Conclusions: There is a diverse assemblage of EcM fungi in Palaeotropical forests of Malaysia that is impacted by land-use changes. The implications of this for dipterocarp nutrition remain to be elucidated.

O19-02 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Plant-soil feedbacks across host mycorrhizal strategies in a mixed Dipterocarp forest.

R. MAX SEGNITZ[1], KABIR PEAY[1], SABRINA RUSSO[2]
[1]Stanford University, Department of Biology, 94305, Stanford, USA
[2]University of Nebraska, School of Biological Sciences, 68588-0118, Lincoln, USA

Background: Biotic feedbacks between plants and associated soil microbial communities have been implicated as important drivers of plant community dynamics. Research in Neotropical forests suggests that negative plant-soil feedback (PSF) may be common mechanism explaining species coexistence in forests dominated by trees forming arbuscular mycorrhizas (AM), whereas positive feedbacks are rare and associated with restricted stands of monodominant ectomycorrhizal (EM) species. Tropical forests of Southeast Asia, in contrast to those in the Neotropics, can include hundreds of EM host species codominant with EM hosts. A majority of studies on tropical PSF have taken place in the Neotropics, and to date no published studies have characterized PSF among both AM and EM hosts in a codominant tropical forest. Here we present the results of a large-scale shade house PSF experiment from northern Borneo, including both AM and EM host species to better understand the role of fungal mutualists in determining feedback strength.
Approach: To assess the generality of negative plant-soil feedback in tropical forests, we established a large-scale shade-house PSF experiment using eight focal tree species including both EM host species as well as AM host species. EM hosts included four species of the dominant Dipterocarpaceae, as well as one species of Fagaceae. Three AM hosts from three different hetero-ordinal families represent phylogenetically varied lineages. To test the role of seedling-soil source phylogenetic relationship in strength and direction of feedback, we grew seedlings of each species in soils collected from beneath a suite of tree species ranging in their phylogenetic relationship to each focal species.
Results: We documented significant effects of seedling-soil phylogenetic distance on seedling growth, though this effect had significant interactions with host mycorrhizal type. Within ectomycorrhizal taxa, phylogenetic relatedness to soil source and soil type had significant effects on percent root colonization by EM fungi, which correlated strongly with seedling growth rates.
Discussion: Our results suggest that in this system the strength and direction of plant-soil feedback is significantly dependent on host mycorrhizal type. We document general trend toward positive feedbacks among EM host taxa, questioning the generality of localized negative plant-soil feedback as a mechanism maintaining plant species diversity in species-rich tropical forests.

O19-03 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

High diversity and high specificity of ectomycorrhizal fungi communities associated with trees from low canopy forests in French Guiana

MÉLANIE ROY[1], HEIDY SCHIMANN[2], LAURA FERNANDEZ[1], JAN HACKEL[1], SOPHIE MANZI[1], ELIANE LOUISANNA[2], DAWN FRAME[3], CONY DECOCK[4]
[1]Université Paul Sabatier, Laboratoire EDB, 31062, Toulouse, France
[2]Laboratoire ECOFOG, 97379, Kourou, French Guiana
[3]Herbier IRD de Guyane, 91323, Cayenne, French Guiana
[4]Université catholique de Louvai, Mycothèque de l'Université catholique de Louvain, 1348, Louvain-la-Neuve, Belgium

Forests of French Guiana (FG) are known for their hyper-diverse tree flora, less for their fungal diversity. First root samplings on terra-firme soils from FG have revealed that only few host species were associated with ectomycorrhizal fungi (EMF). However, fruiting-bodies of EMF were described in the past on the coast, like Cantharellus guyanensis, and re-discovered close to inselbergs. We assume that the occurrence of EMF in low canopy forests, on inselbergs slopes, may be explained by the higher frequency of putative hosts, such as Polygonaceae and Nyctaginaceae, compared to the hyper-diverse forests growing on terra-firme plateau. Considering that these putative host trees often co-occur, we hypothesize that sharing was higher in low canopy forests than in other forests.
We collected EMF fruiting bodies on low canopy forests and plateau around Nouragues inselberg, in French Guiana. We sampled EMF from roots of putative hosts trees belonging to three genera, Coccoloba, Guapira and Neea. Fruiting bodies and EM root tips were sequenced, the later using next generation sequencing.
Based on fruiting bodies survey, the diversity was higher in the low canopy forest and most EMF species were new to science. Based on root sampling, EMF were detected in low canopy forest but not only, and the species richness was rather depending on host identity. Co-occuring host shared only few species, whatever the forest type. Some host trees did not share any fungi, and show a high specificity of association with EMF.
Our study show that EM symbioses survives both in low canopy and hyper-diverse forests of French Guiana, which raises question about their distribution at a larger scale. Our knowledge on EMF is still limited in the lowland amazon, and both the high specificity, and the fruiting habit of EMF may limit their distribution, or our observations.

O19-04 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Mycorrhizal diversity in tropical forests: feedbacks between root-fungal symbioses and soil phosphorus partitioning

JOE TAYLOR[1], XUBING LIU[2], ANDY TAYLOR[3], DAVID JOHNSON[4], THORUNN HELGASON[5], DAVID BURSLEM[6]
[1]University of York, Biology, YO10 5DD, York, UK
[2]Unversity of Aberdeen, Biological Sciences, AB24 2TZ, Aberdeen, UK
[3]James Hutton Institute, Ecological Sciences, AB15 8QH, Aberdeen, UK
[4]Unversity of Aberdeen, Biological Sciences, AB24 2TZ, Aberdeen, UK
[5]University of York, Biology, YO10 5DD, York, UK
[6]University of Aberdeen, Biological Sciences, AB24 2TZ, Aberdeen, UK

High diversity is a striking feature of almost all tropical rain forests, as well as many other ecological communities. This biodiversity provides a range of important ecosystem functions and services, and contributes to the resilience of communities in response to global change. A wide variety of mechanisms have been proposed to explain the origin and maintenance of tropical forest diversity, including resource partitioning, negative density dependence and ecological equivalence. A new and exciting, but currently untested, hypothesis is that resource partitioning for soil phosphorus (P) is one mechanism that could contribute to tropical plant diversity and coexistence. Southeast Asian tropical forests are distinct in that their biomass is dominated by a single family of ectomycorrhizal trees (the Dipterocarpaceae), while most of the diversity of the tree community is represented by species of arbuscular mycorrhizal trees in >100 other families. There is clear potential for specialisation between and within these broad classes of mycorrhizal associations, and this is thought to be one mechanism that may facilitate partitioning for soil P. However, we currently lack vital experimental evidence that would allow this hypothesis to be tested, and so it is essential to gain an understanding of the relationships among mycorrhizal plant and fungal diversity, and soil P fractions, in these systems, and how these associations relate to P utilisation. Our work exploits on-going analyses of plant diversity and couple these with new analyses of mycorrhizal fungal diversity in pristine tropical forest. We will determine the structure of the network of interactions among mycorrhizal plants and fungi in a forest in Borneo, and test whether this is related to edaphic factors including soil P pools.

O19-05 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Recovery of arbuscular mycorrhizal fungi community during tropical forest succession in two soil types

CLAUDIA PANDOLFO PAZ[1], SANDRA ABELL[1], MIRIAM GOOSEM[1], MAARJA OPIK[2], MICHAEL BIRD[1], NOEL PREECE[3], STEVE GOOSEM[4], ROD FENSHAM[5], SUSAN LAURANCE[1]
[1]James Cook University, College of Marine and Environmental Sciences, 4878, Cairns, Australia
[2]University of Tartu, Department of Botany, Institute of Ecology and Earth Sciences, 51005, Tartu, Estonia
[3]Biome5 Pty Ltd, Director, 4883, Atherton, Australia
[4]Wet Tropics Management Authority, Principal Scientist, 4870, Cairns, Australia
[5]University of Queensland, School of Biological Sciences, 4066, Brisbane, Australia

Background: Arbuscular mycorrhizal fungi (AMF) play a crucial role in forests, contributing to plant productivity and soil carbon and nutrients cycles. Mutualist fungi connect plant roots, redistribute soil nutrients which may influence plant establishment and forest regeneration patterns. Around 80% of terrestrial plants have AMF partners, however there is a lack of information on AMF diversity and environmental factors that shape AMF communities for the majority of tropical forests. Hence, we asked whether AMF community structure and composition changes with forest successional stage in two dominant soil types of contrasting nutritional and textural properties in the Wet Tropics of Australia. We first predicted forests in less fertile soils would present higher AMF richness and that richness would increase with successional stage as secondary forests recover soil condition and plant richness as well. Secondly, we expected that AMF community composition would differ with soil type, as they present difference in fertility and texture.
Method: To describe AMF communities we analysed virtual taxa (VT) obtained with DNA analysis (454-pyrosequencing) from soil samples collected in secondary forests at different successional stages and mature (uncleared) forests. Vegetation properties (woody species richness, species dominance and basal area), leaf-litter cover, soil pH, clay content, total nitrogen, phosphorus and potassium and distance from forest fragments were environmental variables used to predict AMF community distribution and similarities.
Result: Our first prediction was partially supported, as mature forest on poorer soil had significantly higher AMF richness than mature forests on the more fertile soil. However, secondary forests on the more fertile soil tended to present higher AMF richness compared to secondary forests on poorer soils. The second prediction was confirmed as we found changes in AMF community composition between successional stages and soil types. The best predictors of AMF richness and community composition were soil pH and total phosphorous rather than woody plant richness or dominance.
Conclusion: AMF richness and community composition change during the course of forest succession. Forest successional stage was important in predicting AMF richness and composition when distinction in soil type is considered. Soil acidity and soil phosphorus content may be more important in structuring AMF communities than woody plant richness.

O19-06 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Preferential carbon allocation to arbuscular mycorrhizal fungi and fungal coexistence in tropical rainforests

BENEDICTE BACHELOT, CHARLOTTE LEE
Duke University, Biology, 27701, Durham, USA

The importance of mutualism in regulating plant population has been recognized for a long time. Evidence accumulates about the role of arbuscular mycorrhizal (AM) fungi in maintaining high tree diversity in the tropical rainforests. AM fungi provide the plants with increased water and phosphorus uptakes and enhanced protection against natural enemies in exchange of carbon. In grasslands and tropical forests, AM diversity has been shown to improve plant survival and production, emphasizing the importance of AM diversity. Recently, a trait-based approach suggested that different functional types of AM fungi might provide different benefits to the plants (nutrients or protection), opening the door to on going partner choice as environmental conditions change.
We combined an AM-trait based approach with Optimal Control Theory to ask if dynamic preferential plant carbon allocation to fungi could result in AM fungal coexistence. To do so, we constructed a dynamic models representing plant population interacting with phosphorus availability and two fungal types: ruderal and competitor. Optimal Control Theory enabled us to uncover the optimal carbon allocation strategy that maximized plant net benefits over an arbitrary period of time. We also asked if dynamic preferential plant carbon allocation could lead to predictable AM fungal community composition at different stages of forest succession. We interpreted our results in the context of published empirical work from tropical and temperate ecosystems.
We found that when fungal biomass was low, the plants allocated to ruderal fungi at low phosphorus availability and to competitor fungi at high phosphorus availability. However, this traditional successional trajectory, from ruderal to competitor, was only observed at low fungal biomass, emphasizing the context-dependency of AM fungal associations. Finally, we found that stable AM coexistence was achieved at intermediate level of resources.
Together our results offer a mechanism for the maintenance of AM fungal diversity and a suit of falsifiable predictions for the composition of AM fungal communities at different stages of forest succession depending on phosphorus availability and fungal biomass. In particular, we discuss how our model reconciles divergent results found in temperate grasslands and tropical rainforests.

O19-07 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Experimental manipulation of fungal communities reveals host-specific effects on seed persistence and survival

CAROLINA SARMIENTO[1], PAUL-CAMILO ZALAMEA[1], LILLIAN HISLOP[2], ANYANGATIA NDOBEGANG[3], ADAM S. DAVIS[4], JAMES W. DALLING[2], A. ELIZABETH ARNOLD[3]
[1]Smithsonian Tropical Research Institute, BCI, 0843-03092, Panama, Panama
[2]University of Illinois, Department of Plant Biology, 61801, Urbana, IL, USA
[3]University of Arizona, School of Plant Sciences, 85721, Tucson, AZ, USA
[4]USDA, Agricultural Research Service, 61801, Urbana, IL, USA

Seeds are critical components of reproduction and fitness for most tropical trees. Accordingly, factors influencing seed survival are important contributors to forest community dynamics. For tropical pioneer species, seed survival depends on the ability to persist in seed banks, where seeds interact with both beneficial and detrimental microorganisms. Fungi are among the most important seed pathogens, yet we have a limited understanding of how seeds defend themselves against infection, and how communities of seed-associated microorganisms assemble. Results of a multi-year, common garden experiment conducted by our group in central Panama suggest that seed-associated fungal communities are shaped primarily by the identity of the plant host species, rather than the timing or location of seed deposition. In vitro experiments suggest that fungi differentially influence germination and survival of seeds of diverse pioneer species. However, the implications of such host preference are not yet clear in the field. We conducted a field-based inoculation experiment to measure effects of focal fungi on seed survival in two species of tropical pioneer trees. Seeds were inoculated with fungal strains, buried in mesh bags in the forest for up to six months, and evaluated to determine microbial community structure, germination, and survival. Although seeds were inoculated prior to burial, microbial communities in retrieved seeds showed a stronger effect of plant species than of initial inoculum. However, inoculation by particular fungi led to different effects on seed viability and persistence in the soil for each pioneer species. Together, these results underscore the distinct and variable roles that microbial taxa play in determining survival of seeds in the soil, and highlight the importance of understanding functional aspects of host preference and community assembly in determining seed fate in tropical forest trees.

O19-08 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Spatial patterns of soil bacterial communities in a lowland Central African Rainforest and sites undergoing agricultural conversion

MEYER KYLE[1], MEMIAGHE HERVÉ[2,3], KORTE LISA[3], KENFACK DAVID[4], ALONSO ALFONSO[3], BOHANNAN BRENDAN[1]
[1]Institute of Ecology and Evolution, University of Oregon
[2]Department of Landscape Architecture, University of Oregon
[3]Smithsonian Conservation Biology Institute
[4]Smithsonian Tropical Research Institute

Forest soil bacterial communities are intimately involved in numerous ecosystem functions that can impact biogeochemical cycling as well as biogeographic patterns of macro-organismal communities. Understanding the factors contributing to the distribution of bacterial taxa is crucial if we are to predict or mitigate the effects of environmental change especially in tropical regions undergoing rapid change. Bacterial activity is an important link between community structure and function yet few have tested whether the active fraction of bacterial communities shows different spatial patterns than the total community (which includes dormant cells). Here we combine RNA/DNA co-extraction and 16S sequencing with a spatially explicit sampling scheme in a lowland rainforest in Gabon, Africa. Our design distinguishes the putatively active bacteria from the total bacterial community and allows us to ask: 1) how spatial patterns differ between the active fraction of the soil bacterial community and the total community, and 2) to what degree geographic distance, the soil chemical environment, and the surrounding tree community structure these biogeographic patterns. In a second study, we applied the same design to a land use change gradient in a nearby region undergoing conversion to agriculture. We found that land use change alters soil bacterial composition, spatial turnover, and phylogenetic diversity and that these differences were more exaggerated in the active fraction of the community. Our results indicate that the active fraction of the soil community may be structured differently than the total community and that soil communities in Gabon may be susceptible to land use change pressure.

O19-09 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Topic modeling of a DNA-based biodiversity survey reveals spatial motifs in 12 ha of neotropical forest

GUILHEM SOMMERIA-KLEIN[1], LUCIE ZINGER[1], AURÉLIE BONIN[2], ERIC COISSAC[2], AMAIA IRIBAR[1], ELIANE LOUISIANNA[3], MAXIME RÉJOU-MÉCHAIN[4], HEIDY SCHIMANN[3], PIERRE TABERLET[2], BLAISE TYMEN[1], JÉRÔME CHAVE[1]
[1]Université Toulouse 3 Paul Sabatier, CNRS, UMR 5174 EDB, 31062, Toulouse, France
[2]Université Grenoble Alpes, CNRS, UMR 5553 LECA, 38000, Grenoble, France
[3]AgroParisTech, CIRAD, CNRS, INRA, University of the French West Indies, University of French Guiana, UMR 745 EcoFoG, 97387, Kourou, French Guiana, France
[4]CNRS, MAEE, UMIFRE 21 French Institute of Pondicherry, 605 001, Pondicherry, India

General patterns of biodiversity, such as the diversity, relative abundance and spatial distribution of organisms, are still poorly known for most groups of biological organisms by lack of rapid and repeatable methods for the measurement of biodiversity. This is especially true in the tropics where most biodiversity is undescribed. DNA-based methods are rapidly transforming this state of knowledge thank to the emergence of high-throughput DNA sequencing. In particular, 'DNA metabarcoding' consists in amplifying and sequencing a genomic marker ('DNA barcode') from the DNA contained in a variety of environmental samples.
Metabarcoding surveys generate large datasets consisting in the abundances of up to tens of thousands of taxa in spatially distributed environmental samples. Retrieving patterns from such community matrices requires methods of dimensionality reduction adapted to their high dimension, discrete nature, sparsity and variability in size among samples. Classical approaches to this problem have relied on multivariate ordination and clustering methods. However, data mining algorithms known as mixture models are a promising alternative. In particular, Latent Dirichlet Allocation (LDA), a method initially developed for classifying text documents into topics ('topic modeling'), may be used to reveal the spatial patterns of co-occurence between taxa.
We extracted the environmental DNA contained in soil samples sampled every 10 m over 12 ha of primary tropical forest at the Nouragues Ecological Station in French Guiana. We amplified and sequenced DNA barcodes targeting bacteria, archaea, fungi, metazoa and plants. By decomposing the resulting environmental DNA dataset using a LDA algorithm, we were able to detect a strong spatial structure in bacteria and archaea, which we could relate with abiotic environmental features. We also found a weaker structure in fungi and metazoa, but no structure in plants. We found that Latent Dirichlet Allocation is an efficient data-mining method to detect structure in the large and complex datasets generated by high-throughput sequencing of environmental DNA, and that it provides an easily interpretable representation of spatial biodiversity in a form that would be otherwise difficult to study.

O19-10 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Microbial dynamics in long-term monitoring plots in Thailand: analysis of the composition and diversity of soil fungi in seasonal tropical forests in Thailand with massive parallel DNA sequencing

SARASA AMMA[1], HIROKAZU TOJU[2], CHONGRAK WACHRINRAT[3], HIROTOSHI SATO[4], AKIFUMI TANABE[5], MAMORU KANZAKI[1]
[1]Kyoto University, Graduate School of Agriculture, 6068502, Kyoto, Japan
[2]Kyoto University, Graduate School of Human and Environmental Studies, 6068317, Kyoto, Japan
[3]Kasetsart University, Graduate School of Silviculture, Faculty of Forestry, 10900, Bangkok, Thailand
[4]Kyoto University, Center for Ecological Research, 5202113, Kyoto, Japan
[5]The Fisheries Research Agency, National Research Institute of Fisheries Science, 2206115, Kanagawa, Japan

Although soil fungi are essential for forest ecosystems to act as decomposers, mutualists, and pathogens and have variety of interactions with many other organisms, little is known about the spatial patterns of the soil fungal community in particular tropical regions. The aim of this study was to elucidate the composition and diversity of soil fungi of seasonal tropical forests in northeast Thailand, to explore the effects of forest types (dry deciduous forest vs. dry evergreen forests vs. dry deciduous forest with fire protection treatment). We collected soils at 50 points at each quadrat within each forest types. Fungal DNA was identified by pyrosequencing analysis. We detected 38,737 sequencing reads and 818 fungal operational taxonomic units (OTUs) in all samples. At phylum level, 70-78% of fungi belonged to Ascomycota and 15-23% was Basidiomycota. Of the 818 OTUs, 90 (11%) and 16 (2.0%) were putatively ectomycorrhizal fungi and arbuscular mycorrhizal fungi. In forest sites, fungal species diversity did not track tree species diversity. Species richness among 7 forest plots did not vary. We found the significant differences of species composition between forest types and between dry deciduous forest plots, whereas there were no significant differences between dry evergreen forest plots. There were significant correlation between soil fungal species composition and tree species composition in dry deciduous forest plots (Mantel statistic r : 0.3043, significance: 0.0001). In dry deciduous forests, fungal species composition varied in response to occupation rate of undergrowth dwarf bamboo, Arundinaria pusilla, (r = -0.73) when seen in plot scale (50 m x 50 m). These results suggest that fungal species diversity did not reflect tree species diversity and was on the same level with each forest plot, and that fungal species composition was structured by not only tree species composition but also coverage of understory vegetation. This study disclosed fungal community structure in main seasonal tropical forest types in Thailand.

O19-11 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

Plant-microbial associations across land use gradients in tropical forests

MCGUIRE KRISTA[1,2], URIARTE MARIA[2], DONLON ROSE[1], QUEBBEMAN ANDREW[2], FIERER NOAH[3], TURNER BENJAMIN[4]
[1]Institution : Columbia University, Barnard College - Department : Biology, 10027 New York - USA,
[2]Institution : Columbia University - Department : Ecology, Evolution and Environmental Biology, 10027 New York - USA
[3]Institution : University of Colorado, Boulder - Department : Ecology and Evolutionary Biology, 80309 Boulder - USA
[4]Institution : Smithsonian Tropical Research Institute - Department : Soils Lab, 20521 Panama City - Panama

Tropical forests are epicenters for macroscopic diversity, but only recently have modern molecular tools enabled the examination of tropical microbial diversity. Plant identity has been frequently cited as a key determinant of microbial composition, due to interspecific differences in chemical microsites that individual tree species create with root and litter inputs. However, land use, which is pervasive in tropical ecosystems, can also alter a myriad of biotic and abiotic factors that are known to affect soil microbial communities, and may modify aboveground-belowground linkages with consequences for plant dynamics and climate feedbacks. In the Luquillo Forest Dynamics Plot in Puerto Rico, we examined the interactive effects of tree identity and land use on structuring soil fungal communities. Specifically, we tested the following hypotheses: 1) Individual tree species have distinctive physical, chemical, phenological, and biological properties that create unique zones of influence, which result in distinct microbial signatures, 2) historical land use is a strong modifier of microbial signatures, and 3) the detection of plant-microbial associations is scale-dependent. We found support for the hypotheses that tree species have unique fungal signatures in the soil and litter for five abundant tree species across the forest dynamics plot. We also found that land use had a more significant impact on fungal composition, likely due to modifications of soil physicochemical properties, but that tree identity was still a factor in determining local scale fungal composition. However, the detection of these signatures was scale-dependent, highlighting the need to sample in a more targeted and definitive manner in order to test plant-microbial associations at the plot scale.

O19-12 – S19 *Plant-microbial interactions in tropical forests: current advances and implications for human-modified environments*
Tuesday 21 June / 10:00-15:30 – Sully1

From terrestrial to epiphytic orchids: do tropics change the rules as compared to temperate regions?

MARC-ANDRÉ SELOSSE[1,2], FLORENT MARTOS[3], MELISSA F. BOCAYUVA[2], CONRADO VIEIRA[2], MARIA CATARINA M. KASUYA[2]
[1]Institut de Systématique, Evolution, Biodiversité (UMR 7205), Muséum national d'Histoire naturelle, Paris, France ;
[2]Department of Microbiology, Viçosa Federal University, Viçosa, Minas Gerais, Brazil ;
[3]Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Saint-Pierre de la Réunion, France

In most mycorrhizal symbioses, including most adult green orchids, fungi provide soil minerals to the plant, in exchange for photosynthetic sugar. Yet, during orchid germination, the fungi, which belong to the polyphyletic rhizoctonias, provide carbon to germinating seedlings that have no reserve. Moreover, in some orchid species, adult plants also recover carbon from their fungi: some are achlorophyllous and non-photosynthetic (mycoheterotrophic species) while others are green but mix photosynthesis and exploitation of fungal carbon (mixotrophic species). Mixotrophic and mycoheterotrophic orchids have lost association to rhizoctonias, but connect (often with high specificity) to ectomycorrhizal fungi, so that their carbon issues from surrounding trees. But this scenario is mostly based on temperate studies – how is it challenged in tropical regions, where additionally most orchids are epiphytic? Our recent researches provide clues on this question. First, and although this was sometimes questioned, epiphytic orchids are always mycorrhizal. We characterized the orchid fungi across the natural habitats of Reunion Island (Pacific) and investigated the architecture of bipartite plant-fungal networks for 73 orchid species and 95 taxonomic units of mycorrhizal fungi. Unlike some recent evidence for nestedness in mycorrhizal symbioses, we found a highly modular architecture that largely reflected an ecological barrier between epiphytic and terrestrial sub-networks. By testing for phylogenetic signal in this network, it was stronger for both partners in the epiphytic sub-network. Moreover, in the sub-network of epiphytic angraecoid orchids, the signal in orchid phylogeny was stronger than the signal in fungal phylogeny. Epiphytic associations are therefore more conservative and may coevolve more than terrestrial ones. Second, our study of tropical mycoheterotrophic and mixotrophic orchids in the paleo- and neotropics revealed that specificity is not the rule and that, if rhizoctonias never support such orchids, the fungal associates can also be wood- or litter-decaying basidiomycetes. What allow these fungal guilds to support plant heterotrophy in the tropics remains unclear, but this suggests gaps in our knowledge of tropical fungal ecology. However, the constant exclusion of rhizoctonias further supports the idea that mycoheterotrophy at adulthood has different physiological bases than orchids mycoheterotrophy at germination.

O20-01 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Community assembly and decomposer function of aquatic fungi along a salinity gradient

ASTRID FERRER, SHAWN BROWN, KATY HEATH, JAMES DALLING
University of Illinois at Urbana-Champaign, Plant Biology, 61801, Urbana, USA

The decomposition of organic matter (primarily leaves and wood) is a key ecosystem process in water, providing much of the energy that sustains aquatic foodwebs. Fungi play the critical role in this process because they are uniquely capable of both penetrating wood and producing the lignin-degrading enzymes that release polysaccharides for heterotroph nutrition. Here we provide an overview of an on-going wood decomposition experiment, replicated across a freshwater to marine salinity gradient in three rivers on Coiba Island National Park on the Pacific coast of Panama. We are using this experiment to (i) explore how environmental factors influence fungal community assembly, (ii) determine which enzymes these fungi use to degrade wood, and (iii) examine how community composition influences the rate and process of decomposition.
We have described the diversity of the aquatic fungal community using a combination of traditional culture-based methods, and environmental sampling of ITS and LSU sequences. DNA extracted from wood has also been sequenced for bacteria and archea using a novel application of the Fluidigm access array system. We found a total of 600 morphospecies based on isolation from fruiting bodies, and 3,840, 19,139, and 4,096 fungal, bacterial and archeal OTUs respectively from environmental sequencing. Communities of all three domains were strongly structured by salinity, but only fungal communities responded to wood decomposition.
In addition to environmental sequencing we have also used 13 primer sets to determine which known gene families encoding for lignocellulolytic enzymes are present in 380 fungal isolates grown from single-spore cultures. Analysis of the distribution of these genes across a large sample of aquatic fungi will reveal the phylogenetic distribution of lignocellolytic activity. Finally, we have directly measured extracellular enzyme activity in a subset of these fungi isolated from freshwater, brackish and marine habitats, and grown under contrasting pH and salinity levels to measure how environment and habitat origin influences enzymatic capacity. The future synthesis of these data will allow us to determine how environment, phylogeny and constraints on enzymatic activity shape fungal community composition and decay processes.

O20-02 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Tropical wood decay: the relative roles of termites and fungi with changing precipitation

AMY ZANNE[1], ALEXANDER CHEESMAN[2], LUCAS CERNUSAK[2], THEODORE EVANS[3], PAUL EGGLETON[4]
[1]George Washington University, Biological Sciences, 20052, Washington, DC, USA
[2]James Cook University, Marine and Environmental Science, 4870, Cairns, QLD, Australia
[3]University of Western Australia, Animal Biology, 6009, Perth, WA, Australia
[4]Natural History Museum, Life Sciences, SW7 5BD, London, United Kingdom

Background: Tropical woody plants are a large carbon sink. Once these trees senesce this carbon can be released quickly back to the atmosphere or remain locked up in the wood for centuries. Fungi and termites are two main carbon loss pathways that can differentially affect how carbon leaves wood. We predict that termites should be relatively more important for wood break down in dry seasons and dry sites than fungi. Methods: We have established two field sites along a 70 km rainfall gradient in Queensland, Australia. The rainforest site receives on average 5144 mm rainfall/year while the savanna site receives on average 900 mm rainfall/year. Both experience annual dry seasons between May and October. To examine the diversity and abundance of termites at the two sites, we carried out termite transect surveys (100 x 2 m) following Jones and Eggleton 2000. To contrast the relative termite breakdown of wood between sites and seasons, at the start of the dry season, we set out pine (Pinus radiata) blocks that were encased in nylon mesh with half of the backs containing holes to allow termite access at 20 stations at both sites. Replicate blocks were harvested at the end of the following dry and wet seasons. At each station, we also placed a toilet paper role to determine rates of station discovery by termites, with rolls replaced approximately every two months. Results: Termite diversity and abundance were higher in savanna than rainforest with termites encountered in 25 substrates in the rainforest versus 7 substrates in the savanna transects. During the dry season, toilet paper rolls were discovered at both sites, meaning termite foraging occurs at ground level at both sites. Additionally, termites were only found to break down wood in the savanna, while overall wood breakdown was faster at the rainforest site. These patterns were even stronger over the wet season. Conclusions: Under global change, temperatures are predicted to be warmer around the globe but rainfall projections are less clear. Some locations will become drier while others become wetter. From our results, we hypothesize that in the Australian tropics, as rainfall levels decrease, termites will take on an increasingly large role in breaking down wood. If this is true, it implies that the locations, forms and rates of carbon release back to the atmosphere from wood will also shift with changes in rainfall.

O20-03 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Microbes drive decomposition and carbon cycling in a rainforest epiphyte microcosm

JULIAN DONALD, SAM BONNETT, PETE MAXFIELD, M.D. FARNON ELLWOOD
University of the West of England, Biological, Biomedical and Analytical Sciences, BS16 1QY, Bristol, UK

Background: Suspended soils, such as those in epiphytes, form important components of the discrete, often limited nutrient pools of tropical forests. The bird's nest fern (Asplenium nidus) is a natural microcosm, which has been used to reveal patterns and processes in canopy invertebrate diversity and rainfall nutrient enrichment. However, little is known of the microbial communities associated with these canopy epiphytes, with almost no information on microbial community composition, or its role in decomposition and nutrient cycling. This is largely due to the difficult nature of working in rainforest canopies, and to the sensitivity of soils to manipulation.
Method: The Eden Project in Cornwall is a unique botanic collection, providing a 'half-way house' between laboratory experiments and in-situ field work. Eden's rainforest biome is highly suited to modelling rainforest processes, in this case canopy soil function. In this study, 13CO2 labelled maize litter was added to the soil of twenty bird's nest ferns which were then suspended at 10 metres in two replicate tree crowns. This was achieved through the development of an innovative canopy platform and irrigation system. The standardised soils were sampled prior to litter addition and installation; and again after intervals of 3 and 6 months. Soil microbial activity was analysed using extracellular enzyme assays. Microbial composition, biomass and carbon uptake were determined using Phospholipid Fatty Acid Analysis (PLFA) and Isotope-ratio mass spectrometry (IRMS).
Results: Suspended soils within the ferns exhibited significant levels of hydrolase and oxidative enzyme activity. PLFA analysis revealed that fern soils had a microbial biomass and community composition comparable to the soil on the ground below. Whilst enzyme activity and biomass decreased over time, IRMS analysis revealed that soil microbial carbon sequestration increased over time.
Discussion: These results show that the suspended soils of bird's nest ferns support functioning microbial communities that actively decompose and assimilate carbon. Microbial community biomass and enzyme activity decreased over time, likely as a response to the drier conditions associated with the canopy environment, but carbon sequestration was unaffected. Given the ubiquity of epiphytes, their associated suspended soil and microbial communities, such microcosms should be considered integral elements of the carbon cycle of tropical forests.

O20-04 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Ectomycorrhizal fungal biodiversity from New Caledonian rainforests on ultramafic soils

FABIAN CARRICONDE[1], MONIQUE GARDES[2], JEAN-MICHEL BELLANGER[3], KELLY LETELLIER[1], SARAH GIGANTE[1], VÉRONIQUE GOURMELON[1], STÉPHANE MCCOY[4], JULIE GOXE[4], JENNIFER READ[5], LAURENT MAGGIA[6]
[1]1Institut Agronomique néo-Calédonien (IAC), Axe 2 "Diversités biologique et fonctionnelle des écosystèmes terrestres", 98800, Nouméa, New Caledonia
[2]2Université de Toulouse-CNRS, UMR 5174 EDB, 31062, Toulouse, France
[3]INSERM, UMR5175, 34293, Montpellier, France
4Vale Nouvelle-Calédonie, Direction de l'Environnement et des Relations Communautaires, 98846, Nouméa, New Caledonia
[5]Monash University, School of Biological Sciences, 3800, Melbourne, Australia
[6]Institut Agronomique néo-Calédonien (IAC)-Cirad, Axe 2 "Diversités biologique et fonctionnelle des écosystèmes terrestres"-UMR AGAP, 98800, Nouméa, New Caledonia

Background: Ectomycorrhizal (ECM) fungi play key roles in ecosystems functioning, such as in plant community dynamic. However, very few studies have been undertaken in the tropics. New Caledonia is an archipelago located in the South West Pacific and is well-recognized for its exceptional biodiversity, especially due to its geographical isolation and the presence of ultramafic soils. In this study, we present the first large molecular study on ECM fungal communities in New Caledonian rainforests from ultramafic soils.
Method: We collected ECM root tips and fruit bodies from three sites located in the South of the main island. In each site, sampling was performed in two monodominant rainforests, with an upper canopy dominated by Nothofagus aequilateralis (Nothofagaceae) or Arillastrum gummiferum (Myrtaceae). Adjacent mixed rainforests were also studied. These formations might represent different successional stages of forest dynamic. Fungi were identified by sequencing the internal transcribed spacer (ITS) of the nuclear ribosomal genes, and host plant were identified as well using the same genomic region.
Results: Out of the 587 ECM root tips and 2372 fruit bodies, 312 OTUs, belonging to at least 29 lineages, were delineated. The community was largely dominated by the /cortinarius lineage in the above- and below-ground communities. Furthermore, community structure analyses strongly suggested host preferences.
Discussion - conclusion: This work increases our knowledge of ECM fungal biodiversity in the tropics, particularly in terms of diversity and dynamic. Indeed, the species diversity seems to be similar to the diversity observed in other tropical and temperate forests and most of the molecular species delineated might be unique to New Caledonia. We could also hypothesise that some fungal groups play major roles in the community dynamic as inoculums sources. Additionally, in the context of land disturbance, the results obtained will permit to develop biological indicators for further conservation and ecological restoration programs of New Caledonian ultramafic ecosystems.

O20-05 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Effect of soil type on soil activity in French Guiana

CLÉMENT STAHL[1], ELODIE COURTOIS[1], ANDREAS RICHTER[2], ERIK VERBRUGGEN[1], JENNIFER SOONG[1], LEANDRO VAN LANGENHOVE[1], DOLORES ASENSIO[3], IVAN JANSSENS[1]
[1]University of Antwerp, Research Group of Plant and Vegetation Ecology, Departement of Biology, 2610, Wilrijk, Belgium
[2]University of Vienna, Department of Microbiology and Ecosystem Science, 1090, Wien, Austria
[3]CREAF, Global Ecology Unit CREAF-CSIC-UAB, 08193, Barcelona, Spain

Climate models predict a range of changes in tropical forest regions, including increased frequency of extreme climatic events, average temperatures and atmospheric CO2 as well as changes in seasonal distribution of rainfall. Effects of rainfall fluctuations on tropical ecosystem functioning and especially soil processes still show contrasting results. Similarly, effects of changes in nutrients availability on soil processes in tropical forest are still not clearly defined. The emission of soil greenhouse gases (CO2 – carbon dioxide, CH4 – methane and N2O – nitrous oxide), produced by both autotrophic and heterotrophic organisms in the soil and enzyme activity can be considered as a proxy of the different soil microbial activity. In fact, emission or uptake of gas could be attributable of different microbial community. We want to know the effect of natural gradient of available P in tropical forest on the full soil greenhouse gas exchange in dry and wet season.
We measured soil fluxes of CO2, CH4 and N2O using opaque static soil chambers at all 2 sites. At each site, we measured 3 habitats (4 plots by habitat): Slope (low available P), Top (mid available P) and Bottom land (high available P). In each plot, GHG fluxes were calculated based on the rate of changing gas concentrations inside the 5 chambers. We will also measure soil enzyme activities related with the P cycle (acid and alkaline phosphatase) in 0-15 cm depth. Soil water content and soil, air temperature were measured in the same time, as well as total and available N and P in the surface soil.
Our results shown that the dry season decrease the fluxes of the gas and also shift the pattern from source to sink for CH4. Increasing available P increase the flux of CO2 (source) and N2O (sink). We found a positive relationship of phosphatase activity and available P. The combining effect of water and nutrients partly explain the equivalent carbon (C) emission of the habitats. In fact, the bottom land are a source of C because it is wetter and richer in nutrients than the two others habitats. These results suggest that the microbial community have not the same response to water in nutrient limitation. So, the increase in nitrogen atmospheric depositions, resulting in changes in the stoichiometry of carbon and nitrogen relative to phosphorus, and the increase of dry season, could generate a deep change in ecosystem and soil functioning for the next decades.

O20-06 – S20 *Free session: Plant-microbial interactions*
Tuesday 21 June / 16:00-17:30 – Sully1

Relationship between soil fungal communities and plant communities, fertility and climate at multiple scales in French Guiana

JENNIFER SOONG, JOHAN DE GRUYTER, CLEMENT STAHL, IVAN JANSSENS, ERIK VERBRUGGEN
University Antwerp, PLECO, 2619, Wilrijk, Belgium

Tropical rainforests are the most diverse and productive ecosystems on Earth. These system account for one third of carbon assimilation on land, and harbor two-thirds of global plant diversity. While mycorrhizal fungi act as a major conduit of carbon into soil, and affect competition between trees through connecting them belowground, the main determinants of these and other soil fungi in tropical forests are still largely uncovered.
In the current study soil was sampled at 12 different forests across French Guiana, and at two sites sampling was performed in the wet (July) and dry (October) season at multiple plots. DNA was isolated from soil originating from two depths, 0-15 cm and 15-30 cm from the surface. The fungal ITS rRNA marker was sequenced using Illumina Miseq, and multiple soil parameters were measured including C/N stocks, pH, and available P. The relative contribution of plant vegetation descriptors (species composition, productivity), soil environmental, and climate predictors was then estimated in terms of explaining soil fungal community composition.

O21-01 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

The pitcher of carnivorous plants: grave or sanctuary for arthropods? The biotic and abiotic drivers of 'living' diversity in the traps of Nepenthes

LAURENCE GAUME[1], VINCENT BAZILE[1], PHILIPPE BOUSSES[2], GILLES LE MOGUÉDEC[1], DAVID MARSHALL[3]
[1]CNRS / Montpellier University, UMR AMAP, 34398, Montpellier, France
[2]IRD / Montpellier University, UMR MIVEGEC, 34394, Montpellier, France
[3]University of Brunei Darussalam, Biology Department, BE 1410, Gadong, Brunei

Background: Most Nepenthes species are vulnerable carnivorous plants that paradoxically harbour in their pitchers a living infauna, the inquilines, adapted to the hostile conditions of the digestive fluid. As this biodiversity might be involved in ecosystemic services, it appears relevant to investigate which Nepenthes species and characteristics are most suitable for life.
Methods: The abundance, species richness and Shannon diversity of the metazoan inquilines were compared among four Nepenthes species in Brunei (Borneo). For 15 newly open pitchers of each species and 15 water glasses chosen as controls, 15 experimental prey items were put into the fluid. The reservoir contents were analysed a month later. Reservoir dimensions and fluid pH were measured and the natural prey and vegetal detritus quantified.
Results: The living diversity in Nepenthes pitchers was much greater than in water controls. According to dissimilarity indices, the inquiline composition of each Nepenthes species was species-specific. Inquiline abundance was determined by pitcher aperture diameter, pitcher volume, fluid pH and prey number. Species richness increased primarily with pitcher aperture diameter and fluid pH. As pitcher diameters are estimators of the inquilines' habitat area, our results partly reflect the well-known species-area relationships.
Conclusion: The Nepenthes pitcher plants may have evolved different strategies of digestion gathering on one side autonomous inhospitable species with narrow pitchers and acidic fluids and on the other mutualistic inquiline-dependant species with large pitchers and weakly-acidic fluids. For a conservation perspective, it appears more relevant to protect Nepenthes species with large pitchers because they are keystone species for a broader biodiversity.

O21-02 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Food webs of phytotelmata in Mulu National Park, Borneo

CATHERINE YULE[1], STEVEN WONG[2]
[1]Monash University, School of Science, 47500, Petaling Jaya, MALAYSIA
[2]Asia Pacific Environmental Consultants, 57100, Kuala Lumpur, MALAYSIA

Borneo has a diverse phytotelm flora despite the absence of Bromeliaceae. These include Nepenthes pitcher plants (Family Nepenthaceae), tree holes, bamboo stumps and internodes, as well as leaf axils and flower bracts. We compared food webs within Nepenthes ampullaria, N. gracilis, tree holes and bamboo (Gigantochloa scortechinii: Bambusoideae) in Mulu National Park, Sarawak, Malaysia. Species of Nepenthes are typically carnivorous, trapping and digesting prey in acidic fluid that contains digestive enzymes, but they also provide a habitat for a wide variety of adapted aquatic fauna. Whereas N.gracilis largely supplements its nutrients by attracting and trapping ants, the lids of N.ampullaria do not cover the pitchers enabling leaf litter to fall in and provide nutrients. Both are inhabited by numerous and diverse dipteran larvae as well as water mites. N. ampullaria grows on the forest floor and the fluid is less acidic than that of most other Nepenthes, which enables it to provide a habitat for the tadpoles of one of the smallest frogs in the world – Microhyla borneensis. The basis of the aquatic food webs were: N. gracilis - the remnants of digested prey; N. ampullaria and tree holes - leaf detritus; and bamboo stumps - leaves and bamboo detritus. Tree holes had the most complex food webs and contained the widest range of fauna (including protozoans, nematodes, annelids, rotifers, microcrustaceans, beetle larvae, dragonfly and damselfly larvae and various tree frogs) because they were relatively large and permanent with less harsh physico-chemical conditions.

O21-03 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Geographic constancy and contingency in the sensitivity of bromeliad food webs to precipitation change

DIANE S. SRIVASTAVA[1], DIMARIS ACOSTA MERCADO[2], PABLO ANTIQUEIRA[3], IGNACIO M. BARBERIS[4], ALICE CAMPOS[5], JEAN-FRANÇOIS CARRIAS[6], JULIANA DA SILVA LEAL[5], OLIVIER DÉZERALD[7], VINICIUS F. FARJALLA[5], RODRIGO FREIRE[4], NICHOLAS DOS ANJOS CRISTIANO MARINO[5], A. ANDREW M. MACDONALD[1], GUILLERMO MONTERO[7], PAULA MUNHOZ DE OMENA[3], M. FABIOLA OSPINA-BAUTISTA[8], GUSTAVO CAUÊ DE OLIVEIRA PÍCCOLI[9], EMILIO REALPE[8], GUSTAVO Q. ROMERO[3], M. KURTIS TRZCINSKI[10], EDD HAMMILL[1]
[1]University of British Columbia, Biodiversity Research Centre, V6T 1Z4, Vancouver, Canada
[2]University of Puerto Rico Mayagüez, Department of Biology, 00680, Mayagüez, Puerto Rico
[3]Unicamp (State University of Campinas), Institute of Biology, 13083-970, Campinas, Brazil
[4]Universidad Nacional de Rosario, Facultad de Ciencias Agrarias, S2125ZAA, Zavalla, Argentina
[5]Universidade Federal do Rio de Janeiro, Department of Ecology, 21941-590, Rio de Janeiro, Brazil
6Université Blaise Pascal Clermont Ferrand, LMGE UMR6023, 63000, Aubière, France
[7]CNRS, Ecofog UMR8172, 97000, Kourou, French Guiana
[8]Universidad de Los Andes, Dept Ciencas Biologicas, 111711, Bogota, Columbia
[9]Unesp (State Paulista University), Dept. of Biology, 15054-000, São José do Rio Preto, Brazil
[10]Université Paul Sabatier, Ecolab UMR5245, 31062, Toulouse, France
[11]Utah State University, Department of Watershed Sciences and the Ecology Center, 84341, Logan, U.S.A.

Background: Precipitation is predicted to change substantially over the Neotropics, potentially affecting the structure and functioning of freshwater ecosystems. However, we are limited in our ability to make generalisations about precipitation changes, as studies have typically been conducted at one study site and only for shifts in mean conditions.
Methods: Here we report on experimental manipulations of rainfall, replicated in 7 sites from 29°S to 18°N, and their impact on a common ecosystem: the aquatic food webs within bromeliads. In each site, we altered the quantity of rain entering bromeliads over a two month period by 50-200%, and the dispersion of this rainfall between days by 10-300%, creating a response surface relative to site ambient conditions. We recorded in each site a common set of macroinvertebrate, microbial and ecosystem functioning response variables.
Results: Shifts in rainfall had general, site-specific or no effect on this aquatic system, depending on the response metric. For example, effects of rainfall on bacterial density were similar across sites. However, macroinvertebrate feeding groups often differed substantially between study sites in their sensitivity to rainfall manipulations. This site contingency likely reflects geographic differences in bromeliad hydrology, litter quality and faunal traits. Despite site contingency, many sites showed optimal functioning near current climatic conditions. Finally, some ecosystem functions were largely resistant to rainfall change, such as decomposition and CO2 flux, despite the extreme range of rainfall change.
Conclusion: This study demonstrates that climate change studies based on single conditions or sites cannot be usefully extrapolated to regional scales; only explicit inclusion of mechanisms will permit generalizations.

O21-04 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
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Functional trait responses of bromeliad invertebrate communities to altered precipitation along a biogeographic gradient

REGIS CEREGHINO[1], IGNACIO BARBERIS[2], JEAN-FRANÇOIS CARRIAS[3], BRUNO CORBARA[3], OLIVIER DEZERALD[4], VINICIUS FARJALLA[5], EDD HAMMILL[6], CELINE LEROY[4], ANDREW MCDONALD[7], GUILLERMO MONTERO[8], FABIOLA OSPINA-BAUTISTA[9], GUSTAVO CAUE-PICCOLI[10], EMILIO REALPE[9], GUSTAVO ROMERO[10], MARK KURTIS TRZCINSKI[1], DIANE SRIVASTAVA[7]
[1]Univ Toulouse, Ecolab, 31062, Toulouse, France
[2]Univ Nacional Rosario, IICAR-UNR-CONICET, S2125ZAA, Zavalla, Argentina
[3]Univ Blaise Pascal, LMGE, 63000, Aubière, France
[4]CNRS-IRD, Ecofog, 97000, Kourou, France
[5]Univ. Federal do Rio de Janeiro, Dept Ecology, 21941-590, Rio de Janeiro, Brazil
[6]Utah State University, Dept Watershed Sciences and the Ecology Center, 84341, Logan, USA
[7]Univ. British Columbia, Biodiversity Research Centre, V6T 1Z4, Vancouver, Canada
[8]Univ. Nacional de Rosario, Facultad de Ciencias Agrarias, S2125ZAA, Zavalla, Argentina
[9]Univ. de Los Andes, Dept Ciencas Biologicas, 111711, Bogota, Colombia
[10]State University of Campinas, Institute of Biology, 13083-970, Campinas, Brazil

Background. Anthropogenic climate change is predicted to increase the frequency and intensity of extreme climatic events such as severe droughts. Yet, we don't know how biological communities will respond to altered precipitation regimes, nor whether responses observed at any given site can be extrapolated to other sites when communities show biogeographic turnover in functional traits that determine how organisms interact with their environment.
Method. We manipulated the amount and frequency of rainfall entering tank bromeliad ecosystems at six field sites ranging from 18°N in the Caribbean to 29°S in South-America. We examined generalities in the response of the functional trait diversity of bromeliad invertebrates to precipitation change, by asking whether (1) precipitation change (notably drought) consistently increase the prevalence of certain functional traits at the expense of other traits, and (2) changes in precipitation patterns have different selective effects than changes in bromeliad hydrology.
Results. Overall, bromeliad hydrology had greater effects on the distribution of abundance-weighted traits within communities than precipitation per se. Drought mostly selected traits that confer in situ resistance to dessication, but also ability to move actively to more suitable microsites under stressful conditions. Traits counter-selected were clearly site-specific, certainly because species pools at the different sites differed in their abundance-weighted trait compositions. However, the magnitude of hydrological effects on trait diversity depended both on baseline, site-specific precipitation regimes, and on how bromeliad size and architectural complexity buffered changes in precipitation.
Conclusion. The composition of the species pool and the buffering capacity of physical habitats determine the extent of community-level, functional responses to altered precipitation regimes in neotropical countries. Theoretical models seeking to link functional traits to environmental conditions in an attempt to predict ecosystem responses to climate change should certainly include turnovers in biological and environmental settings.

O21-05 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Drought indirectly affects a bromeliad food web by altering predator survival and omnivory

SARAH AMUNDRUD, SARINA CLAY-SMITH, BRET FLYNN, MEGAN REICH, DIANE SRIVASTAVA
University of British Columbia, Department of Zoology & Biodiversity Research Centre, V6T 1Z4, Vancouver, Canada

Predators can be important mediators of community and ecosystem responses to climate change. Climate change can alter predation by affecting predator survival, distribution, behaviour, and diet choice. While some attention has focused on the indirect effects of climate change mediated by predator survival, mediation via diet choice remains largely unexplored.
Here, we present the results of two microcosm experiments on aquatic insect communities that examine predator-mediated effects of drought on community and ecosystem responses. Bromeliad-dwelling communities contain several functional groups, including predatory damselfly larvae, facilitative tipulid shredders and scirtid scrapers, chironomid collectors, and culicid filter feeders. Experiment 1 manipulated predatory (damselfly) and facilitative taxa (shredders and scrapers) under a range of experimental droughts, and quantified effects on community structure and ecosystem function (decomposition). Experiment 2 crossed tipulid presence with drought, and quantified the effects on collector and filter feeder survival.
Experiment 1 found that, by decreasing the survival of the top predator damselfly, drought affected the entire food web, altering community composition and decomposition. In particular, drought released tipulids from damselfly predation, increasing detrital decomposition. Experiment 2 found that, under drought, tipulid shredders expanded their functional role from detritivore shredders to also become effective predators of culicids and chironomids.
In both experiments, the indirect effects of drought were mediated by predation, although the mechanisms of how drought affected predation varied. In Experiment 1, the effects of drought cascaded through the food web from the top-down, through disproportionate adverse effects on the survival of the damselfly predator. In contrast, in Experiment 2, drought caused tipulids, previously considered obligate shredders, to become important predators of chironomids and culicids. This drought induced switching of the tipulid's functional role likely resulted from increased encounter rates with prey, which were concentrated in the decreased habitat space (i.e., water volume) under drought. These experiments shed new light on the various ways in which climate change can indirectly affect ecosystems through affecting predation.

O21-06 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Contribution of microorganisms and metazoans to leaf litter decomposition and tank bromeliad mineral nutrition

CÉLINE LEROY[1], CAMILLE BONHOMME[2], JEAN-FRANÇOIS CARRIAS[3], BRUNO CORBARA[3], RÉGIS CÉRÉGHINO[4]
[1]IRD, UMR AMAP, 34398, Montpellier, France
[2]CNRS, UMR AMAP, 34398, Montpellier, France
[3]Clermont Université, UMR LMGE, 63000, Clermont-Ferrand, France
[4]Université de Toulouse, UMR ECOLAB, 31062, Toulouse, France

Background. In Neotropical forests, a substantial fraction of the freshwater available is impounded within the rosettes of tank bromeliads, forming small (but numerous) freshwater microecosystems. The rosettes of bromeliads collect rainwater and leaf litter, and provide a habitat for aquatic organisms ranging from prokaryotes to invertebrates and small vertebrates, and also benefit to terrestrial animals which use them as foraging sites or refuges. They accumulate important amounts of nutrients available as detritus (saprophytic species) or animal prey (carnivorous species), which constitutes a major source of energy and nutrients for the aquatic food webs, as well as the plant itself. We explored how microorganisms and metazoans contribute to two major ecosystem functions -leaf litter decomposition and nutrient cycling- that benefit tank-bromeliad mineral nutrition.
Methods. We assessed the relative contribution of aquatic microorganisms vs. invertebrates to leaf litter mass loss in tank bromeliads in forested and sun-exposed areas of French Guiana using coarse- and fine-mesh enclosures that either excluded invertebrates or allowed them to colonize the leaf litter packs. To evaluate nutrient processing and retention, both natural abundance of delta15N isotope and 15N experimental enrichment were used at the plant level.
Results. We found that changes in the biomass of macroinvertebrate detritivores (and their predators) from forested to open areas did not influence detrital mass loss in bromeliads in French Guiana because leaf litter processing was consistently due to microbial activity. Conversely, the richness/biomass of aquatic invertebrates influences positively the nitrogen content and the leaf delta15N that reflect the part of nitrogen derived from invertebrates. An increase in leaf delta15N might also be due to higher number of trophic levels within food webs. Aquatic invertebrates facilitate nutrient uptake by the plant, but only if both predators and detritivores are present.
Conclusion. We highlight that microbial activity is a critical driver of nutrient dynamics (bottom-up effect) and that the presence of predators enhance nutrient provision to bromeliads (top-down effect).

O21-07 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Bromeliad macro-invertebrate food web stability is driven by higher handling time with increasing prey body mass.

LAURA MELISSA GUZMAN[1], DIANE SRIVASTAVA[1], VINICIUS FARJALLA[2]
[1]University of British Columbia, Zoology, V6T 1Z4, Vancouver, Canada
[2]Universidade Federal do Rio de Janeiro, Ecologia, 21941-901, Rio de Janeiro, Brazil

Background: Stability in food webs is driven by the strength of the interactions between predators and prey. Predator consumption is determined by the attack rate of the predator and how long it takes to handle and consume prey items. However, both of these parameters may vary with the body mass of the prey.
Here we test both theoretically and empirically the effect of prey body size on handling time and attack rate, and thus local stability.
Methods: We first modelled how different effects of prey body size on either attack rate or, handling time affected the maximum prey consumed.
We then studied a macro-invertebrate food web found in Brazilian bromeliads. We empirically determined the attack rate and the handling time of a predatory damselfly larva for five of it's prey species that varied substantially in body mass. Damselfly larvae are generalist, top predators in this food web.
Results: We found that for all theoretical scenarios varying attack rate and handling time, the maximum amount of prey consumed by the predator decreased with prey body mass. The bromeliad food web corresponded to one of the scenarios studied, where the attack rate remained constant as prey biomass increased but, handling time increased, resulting in a negative relationship between the maximum amount of prey consumed and prey body mass.
Discussion: Overall, there is a congruence between the patterns we find in the macro-invertebrate food web and the theoretical scenarios. The bromeliad food web is probably stabilized by stable individually predator-prey dynamics between the top predator and most of its prey species.

O21-08 – S21 *The ecological importance of tank-forming plants in tropical rainforests*
Tuesday 21 June / 10:00-12:00 – Sully3

Bromeliad transplantation buffers microclimate fluctuations and facilitates arthropod diversity in tropical forest restoration

ESTEFANIA FERNANDEZ BARRANCOS[1], JOHN LEIGHTON REID[2], JAMES ARONSON[3]
[1]University of Montpellier, Faculty of Science, 34090, Montpellier, France
[2]Missouri Botanical Garden, Center for Conservation and Sustainable Development, 63166-0299, St. Louis, United States
[3]Centre National de la Recherche Scientifique, Centre d'Ecologie Fonctionnelle et Evolutive, 34293, Montpellier, France

Background: Epiphytes represent 10% of vascular plant diversity worldwide, provide habitat, food, and water for animals, and are key components of water and nutrient cycling in Neotropical forest canopies. Yet epiphytes are also among the slowest colonizers of young secondary forests due to limited dispersal and time-dependent microhabitat availability. Among vascular epiphytes, bromeliads are excellent providers of refugia, nesting, and foraging sites, and represent reliable water sources for canopy and subcanopy vertebrates and arthropods. Moreover, fallen bromeliads can be harvested sustainably from the forest floor, where they are likely to perish. Hence, transplanting fallen bromeliads could be a low-impact, low-cost strategy to assist epiphyte recovery in regenerating forests and facilitate species interactions. We tested whether transplanted bromeliads survive and establish, whether they facilitate arthropod community recovery, and whether they buffer local humidity and temperature.
Method: We transplanted 120 bromeliads from four species into three restoration sites in premontane, southern Costa Rica. After one year, we assessed their survival and compared microclimate and arthropod communities between transplanted bromeliads and adjacent controls.
Results: After one year, 71% of transplanted bromeliads (85/120) had survived and, of these 80% (68/85) had clearly become established. Arthropod abundance inside transplanted bromeliads significantly increased over time and was four times higher than on control branches. Additionally, bromeliad transplants buffered local microclimate, reducing maximum daily temperature and increasing minimum daily humidity.
Discussion: We found that transplantation is a viable restoration strategy for overcoming dispersal limitations in epiphytic bromeliads. Transplants provided relatively stable microenvironments for arboreal arthropods, which is particularly important in light of the disproportionate impact of climate change on arboreal species. Further research is required on the effectiveness and cost-efficiency of this strategy using additional epiphyte species, on the viability of transplanted epiphytes in the long term, and on the impact of unlocked facilitation cascades in promoting further epiphyte colonization.

O22-01 – S22 *Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture*
Tuesday 21 June / 14:30-15:30 – Sully3

A biocultural earth-mound landscape: interactions between termites, earthworms and pre-Columbian raised fields in the Beni Llanos of Bolivia

ANNE ZANGERLE[1], RUMSAIS BLATRIX[2], JOSE LUIS ARAMAYO[4], BRICE ANSELME[5], MÉLISSE DURÉCU[2], DELPHINE RENARD[2], BRUNO ROUX[4], MIKAEL JOUANNE[4], DOYLE MCKEY[3]
[1]Technische Universität Braunschweig, Geoökologie, 38065, Braunschweig, Germany
[2]CNRS, CEFE, 34293, Montpellier, France
[3]Université de Montpellier, CEFE, 34293, Montpellier, France
[4]L avion jaune, 34980, Montferrier sur Lez, France
[5]Universite Paris 1, PRODIG, 75001, Paris, France

Context Vestiges of pre-Columbian agricultural raised fields, varying from long ridges (camellones) to smaller round mounds, are widespread in the seasonally flooded Beni Llanos. As in many seasonal tropical wetlands, earth mounds of natural origin also occur: termite savannas and sartenejales, landscapes featuring densely packed mounds comprised of biostructures produced by earthworms, plant roots and social insects. Study of these mixed landscapes suggests questions about how natural and cultural processes interact. (1) Do human-constructed earthworks affect the distribution and activities of 'natural' soil engineers? (2) Did farmers pre-empt and modify earth mounds of natural origin? (3) Did 'natural' soil engineers play any functional role in pre-Columbian raised-field agriculture ? (4) Can the activities of 'natural' soil engineers explain the persistence of human-made mounds abandoned centuries or millenia ago ? Methods We identified and characterized sites using Google EarthTM satellite imagery, and obtained high-resolution aerial photographs and lidar imagery of selected sites using a drone. In field studies, we quantified soil structure, the distribution of soil 'engineers' (earthworms, social insects, plant roots) and morphology of stable aggregates. Results (1) The distribution of soil engineers is conditioned by that of vestiges of raised fields. Few soil engineers occur on the camellones; termite mounds are concentrated along the edges between camellones and the adjacent ditches; and sartenejales appear in the ditches themselves and in the surrounding basin. (2) Patterns suggest that termite mounds were co-opted and modified by pre-Columbian farmers to make raised fields (as also seen in present-day wetland raised-field agriculture in Zambia). (3) Periodic cleaning of ditches between camellones by famers could have driven the regeneration of sartenejales, creating a renewable source of organic matter for application on the raised fields. (4) On abandoned raised fields, natural soil engineers generate a positive accumulation/erosion balance (maintaining the physical vestiges of raised fields) within a narrow altitudinal range. Discussion Earth-mound landscapes of natural and cultural origin have been studied by different communities of researchers (ecologists and archaeologists, respectively) asking different questions and rarely interacting. Our study shows the necessity of studying these landscapes as products of biocultural interactions.

O22-02 – S22 *Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture*
Tuesday 21 June / 14:30-15:30 – Sully3

Termite mounds as islands of fertility islands and climate regulation in southern Africa

COLLEEN SEYMOUR[1], GRANT JOSEPH[2], DAVID CUMMING[3], GRAEME CUMMING[2], ZACHEUS MAHLANGU[3], ANTONI MILEWSKI[4], ANTHONY MILLS[4], MDUDUZI NDLOVU[5], BERNARD COETZEE[5]
[1]SANBI, Applied Biodiversity Research Division, 7735, Cape Town, South Africa
[2]University of Cape Town, Dept of Biological Sciences, 7701, Cape Town, South Africa
[3]University of Zimbabwe, Dept of Biological Sciences, 0001, Harare, Zimbabwe
[4]University of Stellenbosch, Dept of Soil Sciences, 7600, Stellenbosch, South Africa
[5]Organization of Tropical Studies, Kruger National Park, 1350, Skukuza, South Africa

Background: In nutrient-poor ecosystems, the value of patches of high quality resources is marked. Termite mounds are one example of such patches, and termites in the genus Macrotermes (Macrotermitinae (Blattodea), redistribute soil particles on scales of tens of metres, influencing mineral composition, hydrology, and drainage in landscapes. These changes in turn influence plant and animal species composition, and can influence productivity of the entire biome, as well as microclimates on the mounds themselves. We investigated how the surrounding soils and maturity of mounds affected concentrations of macro- and micronutrients in mounds and the woody plant foliage growing on them. We also investigated how temperatures differed between mound and matrix, to assess whether the plants on mounds contribute habitat heterogeneity by providing refuges from heat.
Methods: In Chizarira National Park, Zimbabwe, we sampled substrate from mounds at four different sites. We collected substrate from 20 large mounds (i.e., diameters > 10m) and substrate from soil in the surrounding matrix 20m from the edges of large mounds, to constitute paired samples. We also sampled substrate from 10 incipient mounds (diameter < 5m), so that in summary, we had samples from each of 20 large mounds, which were each paired with a matrix plot. Ten of the large mounds were also paired with an incipient mound. At Mana Pools National Park, Zimbabwe, and Shingwedzi, Kruger National Park, South Africa, we also measured temperatures on 40 large mounds and matrix plots, to ascertain if mounds are associated with cooler environments.
Results: Although all macro- and micronutrients save ammonium, extractable P, Zn and Se were enriched in large mounds relative to matrix soils, none was significantly enriched in incipient mounds, suggesting that the full nutritional value of mounds is only apparent in large mounds. Average foliar concentrations of N, P and micronutrients in woody plants had maximum values in mounds species. Temperatures on mounds were significantly lower on mounds than in the matrix, and this effect was more marked at high temperatures.
Conclusions
These findings suggest that if herbivores include certain mound species in their diets, they can meet their nutrient requirements. Furthermore, mounds contribute habitat heterogeneity by providing cooler environments, suggesting an important role for them during heat waves.

O22-03 – S22 *Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture*
Tuesday 21 June / 14:30-15:30 – Sully3

Namibian and other fairy circles: different biomass-water feedbacks but identical spatial patterns

STEPHAN GETZIN[1], HEZI YIZHAQ[2], BRONWYN BELL[3], TODD E. ERICKSON[4], ANTHONY C. POSTLE[5]
ITZHAK KATRA[6], OMER TZUK[7], YUVAL R. ZELNIK[2], KERSTIN WIEGAND[8], THORSTEN WIEGAND[1], EHUD MERON[2]
[1]Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modelling, 04318, Leipzig, Germany
[2]Ben-Gurion University of the Negev, Department of Solar Energy and Environmental Physics, 84990, Beer Sheva, Israel
[3]Rio Tinto, Environmental Management, 6000, Perth, Australia
[4]The University of Western Australia, School of Plant Biology, 6009, Crawley, Australia
[5]Private consultant, PO Box 5473, 4870, Cairns, Australia
[6]Ben-Gurion University of the Negev, Department of Geography and Environmental Development, 84105, Beer Sheva, Israel
[7]Ben-Gurion University of the Negev, Physics Department, 84105, Beer Sheva, Israel
[8]University of Goettingen, Department of Ecosystem Modelling, 37077, Goettingen, Germany

So-called 'fairy circles' are round bare-soil patches within dry grassland of southern Africa and elsewhere. These vegetation gaps are regularly spaced, a very general spatial characteristic that they often share with large termite mounds, with gaps created by erosion of termite pavement mounds or created by harvester ants, or with the massive earth mounds like the South African 'heuweltjies' whose origin seems to be strongly affected by aeolian sediment deposition around vegetation clumps. While the individual causes of regular patterning of soil patches may be obviously very different, the specific causal processes should leave a distinct spatial signature in the formation of spatial regularity that can be detected with spatial statistics.
In this talk we will emphasize the importance of the detailed signature of spatial regularity based on the example of the mysterious fairy circles. It will be shown that their extremely ordered pattern is unlikely the result of abiotic gas leakage or the activity of non-mound building termites and ants. Instead, we demonstrate that their typical hexagonal spacing strongly concurs with the hypothesis of vegetation self-organization. As a novel support for this hypothesis we show that fairy-circle formation is not only limited to southern Africa but may also occur in other water-limited systems across the globe. We substantiate our findings by comparing directly the spatial patterns of fairy circles, termite, and ant nests and show that the extremely ordered fairy circle patterns have nothing in common with the distribution of social insects that occur in the same area. We further show that fairy circles may be induced by different biomass-water feedback mechanisms such as soil-water diffusion or overland-water flow but that their spatial distribution pattern is identical because of the same instability type that triggers the vegetation pattern formation.

O22-04 – S22 *Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture*
Tuesday 21 June / 14:30-15:30 – Sully3

The origin and demise of SW Cape heuweltjies ("small hills")

JEREMY MIDGLEY, MICHAEL CRAMER
University Of Cape Town, Biological Sciences, 7701, Cape Town, South Africa

Background The SW Cape landscape is dotted with regularly spaced mounds (heuweltjies) that are about 20 m in diameter, 20 m apart and upto 1.5 m in height. The origin of the mounds is controversial. Because mounds have deeper and more nutrient-rich soils than those off-mound, they typically support a greater vegetation cover and plant height. Mounds also have a different species composition including greater proportions of palatable plants, than off-mound. Herbivory may therefore be more intense on mounds and this may lead to loss of cover on mounds.
Methods At a local scale we sampled cross sections through mounds and analysed these sediments. At a geographic scale we analysed a time series of vegetation cover on mounds from aerial photographs. We also used Google earth images to categorise the present state of vegetation on heuweltjies.
Results The sediments in the mounds are largely aolian in origin with the source of the sediments appearing to largely be local dust, but also with some exotic input of elements, possibly from marine aerosols. Only about 40% of mounds presently have more dense vegetation than off-mound. The loss of cover on mounds occurred > 50 years ago when stocking rates of domestic animals were high.
Discussion Mounds were largely formed by the accumulation of wind-blown sediments, rather than being due to excavation by fossorial animals or due to selective erosion. About 60% of mounds have lost vegetation, probably due to over-grazing by domestic animals. This loss of vegetation will expose mounds to erosion, thus potentially reversing the process that created the mounds.

O23-01 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Food or sex: Solving the pollinator-prey conflict in a carnivorous plant with a whiff of perfume

BRUNO DI GIUSTO[1], JEAN-MARIE BESSIÈRE[2], LINDA LIM[3], LAURENCE GAUME[4]
[1]Ming Chuan University, International College, 111, Taipei, Taiwan
[2]Ecole Nationale Supérieure de Chimie de Montpellier, Laboratoire de Chimie Appliquée, 34296, Montpellier, France
[3]Universiti Brunei Darussalam, Chemistry department, BE1410, Bandar Seri Begawan, Brunei
[4]CNRS/CIRAD, AMAP botAnique et bioinforMatique de l Architecture des Plantes, 34398, Montpellier, France

Background. Nepenthes carnivorous plants, typically found in nutrient-poor habitats, rely on nitrogen derived from prey captured by their pitchers. As with most flowering plants, they also rely on insects to pollinate their flowers. Thus, there is the potential risk that these carnivorous plants may eat their own pollinators. In Nepenthes rafflesiana var. typica, pitchers and inflorescences, both colorful, grow without spatial separation, and both produce nectar and release a sweet smell. We hypothesized that N. rafflesiana may reduce the pollinator-prey conflict through differences in the chemical composition of the volatile compounds emitted by the pitchers and the inflorescences.
Methods. We first investigated which insects appear to be potential pollinators through direct observation and analysis of the flowering characteristics. Then a bagging experiment allowed us to restrict access to the pitchers and inflorescences at different times of the day to evaluate the timing of trapping and pollination. Finally, after capturing the scent of the pitchers and inflorescences on male and female plants over a cycle of 24h, we used gas chromatography-mass spectrometry to analyze the chemical composition in the bouquets of odors emitted by both flowers and pitchers.
Results. While trapping occurred during both day and night, pollination was mainly a nocturnal activity. Although further observations are needed, our results suggest that moths may be the principal pollinators and that a low degree of overlap in the emissions of odors by pitchers and inflorescences combined with the use of a specific chemical signal reduce the chances of pollinator-prey conflict in N. rafflesiana.
Conclusion. Chemical ecology offers new insights in our understanding of mechanisms of attraction in plant carnivory and pollination as well as of the factors affecting the cost and benefits of the carnivorous life-style.

O23-02 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Saving the injured: rescue behavior in the termite hunting ant Megaponera analis

ERIK FRANK, THOMAS SCHMITT, THOMAS HOVESTADT, OLIVER MITESSER, JONAS STIEGLER, EDUARD LINSENMAIR
University of Wuerzburg, Animal Ecology and Tropical Biology, 97074, Wuerzburg, Germany

Predators of highly defensive prey likely develop cost reducing adaptations. The ant Megaponera analis is a specialized termite predator, solely raiding termites of the subfamily Macrotermitinae at their foraging sites. The evolutionary arms race between termites and ants led to various defensive mechanisms in termites, e.g. a caste specialized in fighting predators. As M. analis incurs high injury/mortality risks when preying on termites, some risk mitigating adaptations seem likely to have evolved. These include carrying injured nestmates back to the nest after the hunt.
Field experiments were conducted at the Comoé Research Station located in the Comoé National Park in North-Eastern Côte d'Ivoire. These involved manipulation of individual ants to identify the factors relevant for the rescue behaviour and chemical and gland experiments on dummies for determining the gland and pheromones triggering this behaviour. Additionally at the University of Würzburg gas chromatography/mass spectrometry analyses were conducted for identifying the chemical components in the glands. A model to identify the evolutionary drivers benefiting this rescue behaviour was also developed.
Here we show that a unique rescue behaviour in M. analis, consisting in carrying injured nestmates back to the nest reduces combat mortality. After a fight injured ants, that either lost a limb or have termites clinging on them, emit two pheromone components, dimethyl disulphide and dimethyl trisulphide, harboured in the mandibular gland reservoir, as a call for help. These injured ants amount to 12-20 individuals per day, a quantity similar to the birth rate in a colony (13.3±3.8 ants per day). If these injured ants are forced to return without help they die in 26% of the cases. A model accounting for this rescue behaviour quantifies the value of it to allow for a 21% larger colony size.
Our experiments show a clear reduction of combat mortality, with pheromones in the mandibular gland triggering the rescue behaviour. Thus showing the adaptive value of a rescue behaviour in a social predator specialized on highly defensive prey. A behaviour successful enough to have co-evolved in widely different social systems using distinct mechanisms, like chemical communication in ants or empathy in humans. This convergent evolution allows us to identify the evolutionary drivers necessary for selective rescue behaviour to evolve in animals.

O23-03 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Unspecific chemical mediations in highly specific host-pathogen relations between Ophiocordyceps unilateralis and formicine ants

BARAMEE SAKOLRAK[1], RUMSAIS BLATRIX[2], UTHAIWAN SANGWANIT[1], DONNAYA THANAKITPIPATTANA[3], WASANA NOISRIPOOM[3], ARTIT KHONSANIT[3], NUNTANAT ARNARMNART[3], NOPPOL KOBMOO[3]
[1]Kasetsart University, Department of Forest Biology, Faculty of Forestry, 10900, Bangkok, Thailand
[2]CNRS – Université de Montpellier – Université Paul Valéry Montpellier – EPHE, CEFE UMR 5175, 34293, Montpellier, France
[3]National Center for Genetic Engineering and Biotechnology, National Science and Technology Development Agency, Bioresource Technology Research Unit, 12120, Pathum Thani, Thailand

Background: Chemical defences against microbial pathogens by ants have been largely demonstrated, with a major role played by metapleural glands against generalist pathogens while much less attention has been paid on other glands. Most formicine ants lack metapleural glands and the tribe Camponotini is specifically targetted by the entomopathogenic fungus Ophiocordyceps unilateralis s.l. Therefore, studying chemical interaction in this specific association will give insights not only into the proximal mechanisms mediating specificity but also into the role of exocrine glands beside the metapleural gland in the ants'defence against pathogens.
Method: We investigated the effects of mandibular gland, post-pharyngeal gland and cuticluar extracts of two formicine ants Polyrhachis furcata and Camponotus saundersi against the germination of spores from their specific O. unilateralis species (O. polyrhachis-furcata and O. camponoti-saundersi respectively), and also against a generalist entomopathogenic fungus Beauveria bassiana. The effects of metapleural gland extracts of two ant species, Dolichoderus sp. and Pheidole sp., which are not targetted by O. unilateralis s.l. but found in the same habitat, were also investigated. We identified compounds from the glands of the formicine ants targetted by O. unilateralis using Gas Chromatography and Mass Spectrometry.
Result: Germination of O. unilateralis species was significantly inhibited only by some extracts from P. furcata and C. saundersi, but not in a species-specific manner. Extracts of the metapleural gland of Dolichoderus sp. and Pheidole sp. significantly inhibited the germination of O. unilateralis. In contrast, germination of the generalist fungus B. bassiana was better with extracts from P. furcata and C. saundersi than in control tests. Various compounds were identified in the substances from the glands of both formicine ants but only one was previously shown to have anti-microbial effects.
Discussion: The chemical mediations at the cuticle level cannot explain the one ant/one fungus specificity between O. unilateralis and formicine ants. Surface chemicals of the cuticle and compounds from the investigated glands seem to have no role in the protection of the two formicine ants against entomopathogenic fungi. These compounds may even be used by generalist pathogenic fungi as a signal triggering germination.

O23-04 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Insights into diversification of floral chemical signaling in the Ficus-mutualistic pollinator interaction: the case of Ficus septica in Southeast Asia

LILLIAN JENNIFER RODRIGUEZ[1], LUCIE CONCHOU[6], ANTHONY BAIN[4], ASTRID CRUAUD[3], HSY-YU TZENG[5], JEAN-YVES RASPLUS[3], MAGALI PROFFIT[2], MARTINE HOSSAERT-MCKEY[2], FINN KJELLBERG[2]
[1]University of the Philippines Diliman, Institute of Biology, 1101, Quezon City, Philippines
[2]Centre d'Ecologie Fonctionnelle et Evolutive, Interactions, Ecologie et Sociétés, 34293, Montpellier, France
[3]Centre de Biologie pour la Gestion des Populations, INRA UMR 1062, 34980, Montferrier-sur-Lez, France
[4]National Taiwan University, Institute of Ecology and Evolutionary Biology, 10617, Taipei, Taiwan
[5]National Chung Hsing University, Department of Forestry, 402, Taichung, Taiwan
[6]Swedish University of Agricultural Sciences, Department of Plant Protection Biology, 23053, Alnarp, Sweden

Each Ficus species is associated with one or some mutualistic, host-specific wasps that breed within their closed inflorescence (called fig). Receptive figs ready to be entered and pollinated emit floral odors that attract the short-lived insects. The odor is species-specific. Ficus and fig pollinating wasps constitute the most extreme case of plant-insect co-diversification documented to date. However, little is known about how receptive fig odors may diversify and whether this diversification is concomitant with wasp diversification. We document here genetic differentiation in Ficus septica between Taiwan, Luzon, Negros Occidental and Mindanao and variation in receptive fig odors among locations. We also document the subdivision of the wasps into a species complex with co-occurring species within the region. Finally, using GC-EAD and Y-tube experiments, we show some data on the specific chemical compounds that facilitate wasp response.
Our first set of data suggested that wasps and fig tree had co-diversified within the system of islands, and that receptive fig odors diverged even faster than wasp and plant gene pools. More systematic sampling suggests 1) a more complex situation of intricate diversification and 2) that the pollinators are probably more constrained by ecological conditions than by geographical variation in receptive fig odor.

O23-05 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Trends in floral trait evolution associated with pollinator shifts in Protea (Proteaceae)

SANDY-LYNN STEENHUISEN[1], ROBERT A. RAGUSO[2], STEVE D. JOHNSON[3], JEREMY MIDGLEY[1]
[1]University of Cape Town, Department of Biological Sciences, 7701, Cape Town, South Africa
[2]Cornell University, Department of Neurobiology and Behavior, NY 14853, Ithaca, United States of America
[3]University of KwaZulu-Natal, School of Life Sciences, Scottsville, Pietermaritzburg, South Africa

Evolutionary shifts between pollination systems are often associated with changes in functional floral traits. Shifts from bird to beetle and non-flying mammal pollination in the African plant genus Protea (Proteaceae) are most notably associated with modifications in inflorescence size and olfactory cues. Using headspace sampling and gas chromatography-mass spectrometry of inflorescences, we compared the emission rates and chemical composition of floral scents between several species from each of three main pollination systems. Bird-pollinated species with larger tall colourful inflorescences emitted small amounts of "green-leaf" volatiles and benzenoid compounds, including benzaldehyde, anisole and benzyl alcohol. Beetle-pollinated species produce shorter and more open inflorescences that emit more complex fruity scents, on average 10-fold greater in the amount of scent emitted than odours sampled from bird pollinated species. These fruity scents are dominated by linalool, other monoterpenes and a variety of benzenoids. The highest emission rates and number of compounds was found to be emitted by the nectar in comparison to bracts, petals and pollen of these beetle-pollinated species. Weaker floral scents of small dull-coloured non-flying mammal pollinated Protea species generally resembled fermented food items such as sour milk, honey or yeast. These odours sometimes comprised of buttery-smelling diacetyl and acetoin in combination with dimethyl disulfide, several unknown sesquiterpenes and ketones, but overall did not show consistent trends. These species are visited by a range of mammals with different feeding habits such as granivorous field mice, insectivorous elephant shrews and carnivorous genets and mongooses, confirmed using remote cameras. Behavioural tests with fruit chafer beetles and mice in the laboratory and field confirm that scent cues play a functional role in pollinator attraction. The scent profiles characteristic of these shifts in pollination systems for Protea will be discussed within a phylogenetic context, together with a review of mammal pollination systems and their associated floral traits in South Africa.

O23-06 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
Tuesday 21 June / 16:00-17:30 – Sully3

Deciphering a chemical code: Host location mechanisms in non-pollinating fig wasps

YADAV PRATIBHA[1], BESSIÈRE JEAN MARIE[2], BORGES RENEE M.[1]
[1]Indian Institute of Science, Centre for Ecological Sciences, 560012, Bangalore, India
[2]Ecole Nationale Supérieure de Chimie, Chemistry, 34090, Montpellier, France

Background: In the fig–fig wasp pollination system, non-pollinating fig wasps, such as gallers and parasitoids that parasitize the mutualism by ovipositing from the exterior into the urn-shaped fig inflorescences called syconia, are expected to use a variety of long range and short range chemical cues for successful host location. The hosts in this case are developing fig wasps situated within the syconium and can only be located using chemical and/or mechanical cues. Such hosts are unapparent or hidden hosts.
Method: Behavioral assays were performed with freshly eclosed naive wasps. Syconia with different oviposition histories were presented in no-choice assays and time taken to first oviposition attempt was recorded. Chemical analyses were carried out using TD-GC-MS for volatiles and GC-MS for surface hydrocarbons and chemical footprints.
Results and Discussion: In behavioural assays with a community of fig wasps occupying syconia of Ficus racemosa, non-pollinating fig wasps exhibited a preference for syconia previously exposed to conspecifics over syconia exposed to heterospecifics and over syconia unexposed to oviposition by any fig wasps. Both gallers and parasitoids exhibited aggregation for oviposition on certain syconia indicating the possible role of chemical signatures left by previously ovipositing wasps. This aggregation behaviour may result from an avoidance of inbreeding resulting from local mate competition within syconia, since wasp offspring can only mate within syconia. We investigated the role of syconial volatile profiles and surface hydrocarbons to understand the hierarchy of host location cues. We also analysed the chemical footprints of these wasps. Our results show that volatile profiles of individual syconia change with wasp occupancy and may be used to identify hidden hosts at long range whereas close range preference seems to be based on exploitation of wasp footprints that cause changes in syconium surface hydrocarbon profiles. Wasp footprint profiles differed quantitatively and qualitatively between the galler (Sycophaga fusca) and the parasitoid (Apocrypta sp 2) species and, along with other chemical cues, could be a reliable indicator of the oviposition history of the syconium, thereby helping wasps in their oviposition decisions.

O24-01 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Divergence and Convergence in High Altitude Specialists

LEONARD JENNIFER
Estación Biológica de Doñana, CSIC, Conservation and Evolutioanry Genetics Group, 41092, Sevilla, Spain

Background: High altitude environments in the tropics can be very different that adjacent lowland areas. These habitats are inhabited both by high altitude specialists and by species distributed along large altitudinal gradients.
Methods: We use genetic tools in combination with other data to measure divergence between high and low altitude populations and between different highland populations of small mammals.
Results: Surprisingly high levels of genetic divergence were found in several, but not all, species. Convergence in some morphological traits across divergent taxa have lead to taxonomic confusion in some cases.
Discussion: High altitude populations are more divergent than expected in many cases, and may be subject to different, habitat specific selective forces.

O24-02 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Hydro-meteorological spatio-temporal variability in an eastern Andean Tropical montane cloud forest (Orinoco River Basin)

BEATRIZ RAMIREZ[1], RYAN TEULING[3], LAURENS GANZEVELD[4], RIK LEEMANS[5]
[1]WU, ESS, 6708PB, Wageningen, The Netherlands
[2]ABC, CEAO, 0000, Yopal, Colombia
[3]WU, HQWM, 6708PB, Wageningen, The Netherlands
[4]WU, MAQ, 6708PB, Wageningen, The Netherlands
[5]WU, ESA, 6708PB, Wageningen, The Netherlands

Background: Along tropical elevation gradients, climate, ecosystem and hydrological interactions are specific and heterogeneous. Despite the relevance of mountain ecosystems for runoff generation, these interactions are poorly understood and represented in hydro-meteorological monitoring networks and regional or global earth system models. A typical case is the South American Tropical Montane Cloud Forests (TMCF), whose water balance is strongly driven by fog persistence. Given the dependence of fog persistence on local and on upwind temperature and moisture, continental TMCF conservation relies not only on local but also on upwind land use management.
Method: Hydro-meteorological data were collected at three gauged neighbouring catchments with contrasting TMCF/grassland cover and elevation extents, from June 2013 to May 2014 and includes hourly solar radiation, temperature, relative humidity, wind speed, precipitation, soil moisture and runoff measurements.
Results: The studied elevational range (1550-2150 m asl) showed wetter and less seasonally contrasting conditions at higher elevations. This indicates a positive relation between elevation and fog or rainfall persistence. The milder dry season hydrological effect on the highest elevations reflected on the different runoff volumes of the catchments and on soil moisture data. The catchment under a stronger fog/rainfall influence presented the highest dry season runoff volumes, whilst the catchment with a weaker fog/rainfall influence presented the lowest. Differences in intensities of extreme runoff events during the wet season indicate that TMCF reduce the extreme event runoff in contrast to the less forested catchment which showed faster rainfall runoff responses, and hence higher peak runoff. Soil moisture data indicated that forests do not use persistently more water than grasslands.
Discussion: Dry season runoffs are sustained by rainfall and fog persistence at higher elevations. A reduction in fog/rainfall persistence will considerably affect the hydrology in these forests. Therefore, localized land use management is not enough for preserving TMCF due to their links with the lowland upwind land cover and hydrological dynamics. TMCF vulnerability to local and upwind land cover and climate change allows us to monitor the magnitude and direction of climate and land cover changes and their hydrological impacts on regional scales.

O24-03 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Spatial and temporal patterns of turnover and productivity in Northern Andean forests

SELENE BAEZ[1], JUERGEN HOMEIER[2]
[1]Consorcio para el Desarrollo Sostenible de la Ecoregion Andina, Environmental Studies, 000, Quito, Ecuador
[2]University of Gottingen, Plant Ecology, 37073, Gottingen, Germany

Background: General patterns of forest dynamics and productivity in the Andes Mountains, a critical biodiversity hotspot, remain poorly characterized due to the scarcity of studies and the complexity of environmental variation in these topographically complex systems. The lack of knowledge about the influence of climate on dynamics and productivity in Andean forests is of special concern in the face of on-going and future climate change. There is increasing evidence that temperature and precipitation patterns are shifting in the Andean region, and that Andean forests are already responding to environmental changes. For example, trees in the Peruvian Andes have shifted their distributions upslope over the past decades potentially in response to rising temperatures. Recent research shows that Andean tree species are shrinking their population ranges due to higher environmental temperatures. In addition, higher elevation humid Andean forests, distributed seem to be experiencing higher than expected mortality rates of trees in the smaller size classes. Thus, this study uses a large set of permanent forest plots distributed widely in the tropical Andes to investigate in depth how these ecosystems are responding to human induced environmental changes.
Methods: We used Repeated Measures Linear Mixed Models to evaluate how tree mortality, recruitment, growth, and biomass accumulation rates across tree size classes are affected by environmental variation, and through time. We evaluated these spatial and temporal trends on forest dynamics using data collected in >100 permanent forest monitoring plots set in undistrurbed forests distributed in Colombia, Ecuador and Peru, where trees ≥ 10 cm of diameter at breast height (DBH) were identified and measured for diameter at least twice.
Results: Our initial analyses showed that tree turnover, tree growth rate, and basal area increase rates decreased with elevation. There are certain groups of Andean forests that show a tendency to lose biomass, but the relation between biomass loss and environmental change is not well defined yet.
Discussion: This study has provided critical information about how environmental factors affect forest dynamics in the Tropical Andes. Our approach has let us characterize the relationship between turnover and productivity in the region. As part of the present project, we are still investigating what groups of Andean forests have demonstrated sensitivity to recent environmental changes.

O24-04 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

DNA metabarcoding reveals common patterns in altitudinal turnover of functional groups of fungi in Borneo and in the Andes

JÓZSEF GEML[1], EDUARDO NOUHRA[2]
[1]Naturalis Biodiversity Center, Biodiversity Dynamics, 2233CR, Leiden, Netherlands
[2]CONICET-IMBIV, Mycology, 5000, Córdoba, Argentina

Montane forests harbor tremendous biodiversity and high rate of endemism and provide crucial water supplies to human settlements and agricultural areas. Fungi represent one of the largest groups of living organisms and play central roles in the functioning of terrestrial ecosystems as plant symbionts, pathogens, and decomposers. Nevertheless, the vast majority of biodiversity studies have focused on vascular plants and animals and very little is known about the diversity and distribution patterns of fungi in tropical mountains.
We carried out DNA metabarcoding of ITS2 rDNA from soil samples taken along multiple altitudinal gradients in the Yungas in NW Argentina and on Mount Kinabalu and in the Crocker Range in Malaysian Borneo. The sampled sites represent the all major altitudinal forest types from ca. 500 to 2500 m asl in the Yungas and from 300 to 4000 m asl in Borneo.
Our deep sequence data suggests that fungal diversity is comparable across the different zonal forest types and sampling regions. However, all statistical analyses suggested that fungal community composition correlated strongly with forest type in both sampling regions, with many taxa showing strong preference for a certain elevation zone.
Total fungal diversity does not appear to decrease significantly with increasing altitude, which differ markedly from patterns observed in plants and animals. Rather, different functional groups prefer certain altitudinal forest zones and such altitudinal turnover of taxa apparently does not affect substantially the total fungal richness in each zone. Several functional groups show similar distributional trends in Borneo and the Andes, e.g., saprotrophic fungi are more diverse at lower elevations, while root endophytes are dominant at higher altitudes. On the other hand, there are some differences in the distributional patterns of ectomycorrhizal fungi that may be explained by the differential availability of host trees. We document strong correlations between fungal community composition and altitudinal vegetation zones in tropical mountains, likely resulting from direct and indirect interactions, e.g., symbiotic associations, substrates for decomposing fungi, and altered environmental (microclimatic, edaphic etc.) factors. Our study offers an unprecedented insight into the high diversity and spatial distribution of fungi in the tropical and subtropical montane forests.

O24-05 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Elevational sensitivity in an Asian 'hotspot': moth diversity across elevational gradients in tropical, sub-tropical and sub-alpine China

LOUISE A. ASHTON[1], AKIHIRO NAKAMURA[2], ROGER L. KITCHING[3]
[1]Natural History Museum, London, Life Sciences, SW75BD, London, UK
[2]Xishuangbanna Tropical Botanic Garden, Key Laboratory of Tropical Forest Ecology, 666303, Mengla, China
[3]Griffith University, Environmental Futures Research Institute, 4111, Brisbane, Australia

South-western China is widely acknowledged as a biodiversity 'hotspot': there are high levels of diversity and endemism, and many environments are under significant anthropogenic threat, not least climate warming. Here, we explore diversity and compare response patterns of moth assemblages among three elevational gradients established at different climatic bioregions - tropical rain forest, sub-tropical rain forest and sub-alpine mixed forest in Yunnan Province, China. We hypothesised that tropical assemblages would be more elevationally stratified than temperate assemblages, and tropical species would be more elevationally restricted than those in the temperate zone. Contrary to our hypothesis, the moth fauna was more sensitive to elevational differences within the temperate transect, followed by sub-tropical and tropical transects. Moths in the cooler and more seasonal temperate sub-alpine gradient showed stronger elevation-decay beta diversity patterns, and more species were restricted to particular elevational ranges. Our study suggests that moth assemblages are under threat from future climate change and sub-alpine rather than tropical faunas may be the most sensitive to climate change. These results improve our understanding of China's biodiversity and can be used to monitor future changes to herbivore assemblages in a 'hotspot' of biodiversity.

O24-06 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Altitudinal range shifts of plants on Sundaland as result of predicted future climate change

NIELS RAES[1], SAW LENG GUAN[2], PETER C. VAN WELZEN[1], J.W. FERRY SLIK[3]
[1]Naturalis Biodiversity Center, Biodiversity Dynamics, 2300RA, Leiden, Netherlands
[2]Forest Research Institute Malaysia, FRIM, 52109, Kuala Lumpur, Malaysia
[3]3Universiti Brunei Darussalam, Faculty of Science, BE1410, Gadong, Brunei Darussalam

Sundaland is the western part of the Southeast Asian biodiversity hotspot including Borneo, Sumatra, Java and the Malay Peninsula which formed one land mass for most of the Quaternary during glacial periods. Sundaland harbours an extensive volcanic chain along the western coast of Sumatra, continuing on Java, highlands in the centre of the Malay Peninsula, and the highest mountain between the Himalayas and New Guinea, known as Mount Kinabalu on Borneo, part of the Crocker Range. By combining digitized botanical collection records of Naturalis Biodiversity Center (former National Herbarium of the Netherlands), the Forest Research Institute Malaysia (FRIM) and the Singapore Botanical Gardens, with spatial data on quantitative soil and bioclimatic conditions it is now possible to estimate species' niches, and their reciprocal spatial distributions, using ecological niche models (ENMs) for the 50 most diverse tropical plant families treated in Flora Malesiana. After testing the ENMs for significant deviation from random expectation with a bias corrected null-model, and corrected for island endemism, the significant ENMs are projected to two future bioclimatic datasets for the year 2080; knowingly the most optimistic future climate scenario (CMIP5 - rcp 2.6) resulting in a globally increased temperature of 2°C by the year 2100, and the worst case scenario (CMIP5 - rcp 8.5) resulting in a 4°C increased global temperature. Not to rely on a single global climate model (GCM) we use an ensemble output of 17 CMIP5 GCMs. We summarize the predicted future altitudinal range shifts, and related habitat loss or gain, as result of global warming allowing unlimited dispersal capacity and no dispersal for all plant species with a significant ENM. Finally, the potential present and future distributions are corrected for current land use.

O24-07 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

The importance of microbial community composition in determining climate change effects on soil carbon cycling in the tropical Andes

JEANETTE WHITAKER[1], NIALL MCNAMARA[1], NICK OSTLE[2], ANDREW NOTTINGHAM[3], RICHARD BARDGETT[4], NORMA SALINAS[5], ADAN CCAHUANA[6], PATRICK MEIR[7]
[1]Centre for Ecology & Hydrology, Plant-Soil Interactions, LA1 4AP, Lancaster, United Kingdom
[2]Lancaster University, Lancaster Environment Centre, LA1 4YQ, Lancaster, United Kingdom
[3]University of Edinburgh, School of Geosciences, EH9 3JW, Edinburgh, United Kingdom
[4]The University of Manchester, Faculty of Life Sciences, M13 9PT, Manchester, United Kingdom
[5]University of Oxford, School of Geography and Environment, OX1 3QY, Oxford, United Kingdom
[6]Universidad Nacional de San Antonio Abad, Facultad de Ciencias Biologicas, 733, Cusco, Peru
[7]Australian National University, Research School of Biology, ACT 2601, Canberra, Australia

The Andes are predicted to warm by 3–5 °C this century. This rapid warming is expected to change plant species distributions and thus the amount and complexity of plant inputs to the soil. This may, in turn, accelerate soil organic matter mineralization through "positive priming effects", altering the quantity of soil-derived CO2 released to the atmosphere. However, the mechanisms determining the magnitude of changes in soil carbon (C) cycling in response to climate change are poorly understood.
Here we used soils from a 3200 m elevation gradient of contiguous tropical forest in the Peruvian Amazon-Andes, to probe the indirect effects of climate warming on soil C cycling. We determined how soil microbial communities and abiotic properties differed with elevation. We then tested how these differences affected soil respiration responses to plant C inputs using 13C substrates as surrogates.
We found no consistent patterns in priming effects with elevation. Instead substrate quality was shown to be the dominant control on priming effects. Our results show that the relative abundance of microbial functional groups is an important predictor of soil respiration responses to changing C inputs along this elevation gradient and that this can be attributed to functionally distinct microbial groups.
Our findings suggest that the microbial pathways by which plant inputs and soil organic matter are mineralized are determined primarily by the quality of plant inputs and the functional diversity of microbial taxa, rather than the abiotic properties of the soil. These results are consistent with our other research from this gradient showing that the temperature sensitivity of decomposition is regulated by the chemical composition of plant litter and both the physical and chemical composition of pre-existing soil organic matter. Changes in the complexity of plant inputs to soil in response to climate change will therefore be important regulators of C dynamics in tropical forest soils.

O24-08 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Similar but not equivalent: ecological niche comparison across closely-related Mexican white pines

JESÚS AGUIRRE GUTIÉRREZ[1], HÉCTOR M. SERNA-CHAVEZ[2], ALMA R. VILLALOBOS ARÁMBULA[3], JORGE A. PÉREZ DE LA ROSA[3], NIELS RAES[1]
[1]Naturalis Biodiversity Center, Biodiversity Dynamics, 2333CC, Leiden, Netherlands
[2]University of Amsterdam, IBED, 1090GE, Amsterdam, Netherlands
[3]Universidad de Guadalajara, CUCBA, 44600, Guadalajara, Mexico

Background: In the face of global environmental change, identifying the factors that shape the ecological niches of species and understanding the mechanisms behind them can help draft effective conservation plans. The differences in the ecological factors that shape species distributions may then help to highlight differences between closely;related taxa. We investigate the applicability of ecological niche modelling and the comparison of species distributions in ecological niche space to detect areas with priority for biodiversity conservation given climatic changes, and to analyse differences in the ecological niche spaces used by closely-related taxa. As location we use the United States of America, Mexico and Central America.
Methods: We apply ordination and ecological niche modelling techniques to assess the main environmental drivers of the distribution of Mexican white pines (Pinus: Panacea) and the possible impacts of future climatic changes. Furthermore, we assess the similarities and differences of the ecological niches occupied by closely related taxa. We analyse whether Mexican white pines occupy similar or equivalent ecological niches.
Results: We found that all the studied taxa presented different responses to the environmental factors, resulting in a unique combination of niche conditions. Our stacked habitat suitability maps highlighted regions in southern Mexico and northern Central America as highly suitable for most species in the present and thus with high conservation value. However, the area of distribution of these Mexican white pines may drastically change given future climate change. By quantitatively assessing the niche overlap, similarity and equivalency of Mexican white pines, our results prove that the distribution of one species cannot be implied by the distribution of another, even if these taxa are considered closely related.
Conclusions: In face of global climate changes the fact that each Mexican white pine is constrained by a unique set of environmental conditions, and thus their non-equivalence of ecological niches, has direct implications for conservation as this highlights the inadequacy of one-fits all type of conservation measure.

O24-09 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Upslope Andean tree migration is due to pervasive range contraction

WILLIAM FARFAN-RIOS[1], MILES R. SILMAN[2], KENNETH FEELEY[3], YADVINDER MALHI[4], SASSAN SAATCHI[5]
[1]Wake Forest University, Biology, 27106, North Carolina, USA
[2]Wake Forest University, Center for Energy, Environment and Sustainability, 27106, North Carolina, USA
[3]Florida International University International, Biology, 33156, Florida, USA
[4]Oxford University, Environmental Change Institute, School of Geography and the Environment, OX1 3QY, Oxford, UK
[5]Jet Propulsion Laboratory - NASA, California Institute of Technology, 91109, California, USA

Tree species are predicted to shift their distributions to cooler environments (species migration) in response to global climate change. This prediction is supported by increasing studies documenting tree migration in tropical ecosystems at community level. However, our knowledge of how tropical tree species are shifting their distributions in response to climate change and increasing temperatures is still poorly understood. To test the upslope tree species migration hypothesis, we asked (1) if there was a consistent tree community migration over time, (2) for the first time, we examined migration rates for individual species; additionally, (3) we tested whether the observed migration rates were related to mortality or recruitment rates.
The study site was located in the eastern slope of the Peruvian Andes, the highest biodiversity and longest Andes-to-Amazon elevational gradient. Field data was collected for adult trees in multiple censuses over a decade (2003-15) in 23 1-ha permanent plots. Changes in migration rates were taken at community level and also calculated for individual species. Tree species were selected following the criteria of having more than 50 individuals, and occurring at least in three of the 23 plots across the gradient.
Results show a consistent shift for Andean trees in their mean distribution, 82% of the plots showed a positive upslope migration rates with increasing trees abundance, the overall observed mean community migration rates correspond approximate to 1.45 m y-1 (+/- 0.96 m yr-1 CI). Of the 21 species selected 71% increased their mean rate. We estimate that the mean rate for those species was 1.23 m y-1 (+/- 1.45 m yr-1 CI) and Ocotea insularis was the specie with the greatest shift in their distribution (14 m yr-1). The overall observed rates were driving mainly by mortality episodes.
This findings support the previous results of upslope distributions shifts for tropical trees due to elevated temperatures, showing a directional change in species composition. Although the observed migration rates are slower than the predicted regional warming, 15 tree species from 21 were in pace with warming. This pervasive range contraction reflects the fundamental asymmetry between rates of demographic processes, adults take a long time to grow but die quickly. If this isn't balanced by upslope recruitment, it suggests that trees will not be able to tolerate novel temperatures, or at least will go through landscape wide bottlenecks.

O24-10 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

The influence of land-use and climate change on hummingbird diversity in the Andes

CATHERINE GRAHAM[1], LAURA GRAHAM[1], BEN WEISTEIN[1], SARAH SUPP[2], BORIS TINOCO[3], MATTHIAS SCHLEUNING[4]
[1]Stony Brook University, Ecology and Evolution, 11789, Stony Brook, USA
[2]University of Wisconsin-Madison, Department of Geography, 53711, Madison, USA
[3]University of Azuay, Department of Biology, 0000, Cuenca, Ecuador
[4]Senckenberg Biodiversity and Climate Research Center, Senckenberg Biodiversity and Climate Research Center, 0000, Frankfurt, Germany

Background: On going land-use and climate change will influence different facets of biological diversity including: species richness, phylogenetic diversity, trait diversity and the diversity of interactions. At the broad scale, we use species distribution modeling to evaluate the spatial patterns of future no-analog assemblages across species, phylogenetic and trait dimensions. At the local scale we evaluate how trait diversity and plant-animal interactions vary across disturbance and climate gradients. We use hummingbirds as a model system. Hummingbirds are a diverse clade with well-studied traits, high local richness, and high beta diversity along a wide elevation and precipitation gradient. Due to their mutualistic association with floral resources and their tight physiological constraints, hummingbird species richness and geographic ranges may be correlated with environmental features such as temperature and precipitation.
Aim: Under climate change, it is likely that as species reshuffle based on their environmental tolerances no-analog communities will form. It is important for future monitoring and conservation that we understand these no-analog communities. Here we investigate the geographical and environmental patterns of novel and disappearing communities; whether these patterns hold across dimensions (taxonomic, phylogenetic and functional) of diversity; and how these no-analog communities are characterized in trait space.
Methods We used ensemble species distribution modelling to estimate the distributions of 151 hummingbird species into the projected climate for 2070. Using standard beta-diversity measures, we identified novel and disappearing taxonomic, phylogenetic and functional communities.
Results: We found that no-analog hummingbird communities are likely to form under climate change, particularly in extreme environments and with novel communities replacing disappearing. Although the patterns of no-analog communities were similar between dimensions of diversity, we found that there were fewest novel and disappearing functional communities. The no-analog communities were characterised by an increase in functional space, which is counter to typical predictions of trait homogenization under climate change.
Main conclusions: No-analog communities are likely to pose management challenges for future conservation. Here we have presented a framework which offers a logical and methodical way to evaluate no-analog communities.

O24-11 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

The future of forests of the Andes to Amazon gradient: Connecting biodiversity, community composition, and ecosystem services under climate change

MILES R. SILMAN[1, 2]
[1]Wake Forest University and Center for Energy, Department of Biology Environment and Sustainability, 1834 Wake Forest Rd, Winston Salem NC 27106, USA
[2]The Andes Biodiversity and Ecosystem Research Group (ABERG)

The eastern slope of the Andes and adjacent Amazon harbor earth's highest biodiversity, due in large part to species turnover along a large elevational gradient. Moreover, the ecosystem properties of tropical forests are an epiphenomenon of species composition and species functional traits, with most of the functional variation in communities due to among-species differences. This talk presents data from a 3500 m Andes to Amazon elevation gradient in SE Peru to give the static patterns of biodiversity and ecosystem properties of productivity and carbon storage, and their responses to climate change. Demographic analysis shows that in this system species distributions are shifting, mainly due to pervasive range contraction from mortality due to ongoing warming and drought. Future community composition, diversity, and ecosystem function depends on whether rates of warming create large lags in ecosystem responses as species must migrate and re-establish for ecosystem properties to change, or whether the portfolios of species present at a site buffers ecosystem response to climate change.

O24-12 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
Tuesday 21 June / 10:00-15:30 – Antigone1

Conservation planning for tropical montane forests

KENNETH R. YOUNG
Department of Geography and the Environment, University of Texas at Austin, Austin, TX 78712, USA

The biological diversity of tropical mountains is associated with great place-to-place heterogeneity in species assemblages, organized along complex biophysical gradients of elevation and humidity, and subject to current climate change. These mountains also contain landscapes utilized for human settlements, agriculture, and water sources. Thus, the biodiversity legacies and ecosystem services of montane forests are increasingly recognized as globally significant, although important conservation dilemmas exist. For example, many species of concern persist in nonforest situations such as within shrublands or as survivors in forest fragments, complicating targeting of useful interventions. The forests themselves may persist under seemingly unsuitable biophysical conditions due to the longevity of trees or microclimatic amelioration. In addition, it may be that ecotones represent harbingers of future change, for example with treeline shifts that imply that appropriate upslope connectivity is needed for future conservation needs; nevertheless, there are topographic, land use, and land tenure constraints that frequently intervene. The general expectation is that species ranges will shift in individualized ways, complicating predictions. Finally, the pervasiveness of human influences in the humid and dry forest types means that often only perhumid sites have large, intact tracts of forest. As a result, conservation strategies will need to carefully evaluate 1) the usefulness of ecological restoration or valuation efforts in sites now dominated by crops, rangeland, or plantations; 2) the practical, genetic, and ethical dimensions of assisted migration projects for species of concern; and 3) whether protected areas and conservation corridors will suffice for other situations. These assessments would require more active forms of conservation than historically has been the case, as often inaccessibility provided passive protection. For this task, novel institutions will need to be fostered.

O24-13 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation* Tuesday 21 June / 10:00-15:30 – Antigone1

Naturalis Biodiversity Center
HAN TER STEEGE

O25-01 – S25 *Harvest as herbivory: New developments in theoretical and empirical models*
Tuesday 21 June / 16:00-17:30 – Antigone1

Effects of harvest, rainfall and phorophyte (host tree) genus on the population dynamics of an epiphytic bromeliad

TAMARA TICKTIN[1], DEMETRIA MONDRAGON[2], OROU GAOUE[1]
[1]University of Hawaii, Botany, 96821, Honolulu, USA
[2]Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, CIIDIR, 71230, Oaxaca, Mexico

Background: Vascular epiphytes constitute an estimated 10% of global vascular plant diversity and 25% of tropical plant diversity. Many species of vascular epiphytes are also heavily harvested from the wild for local, national and international horticulture trade. However, the natural and anthropogenic factors that drive their long-term population dynamics are still poorly understood. We tested the single and combined effects of harvest, host tree (phorophyte) genus, and rainfall on the populations of an epiphytic bromeliad, Tillandsia macdougallii, a common and heavily harvested species endemic to the montane forests of Oaxaca, Mexico.
Methods: We carried out a five-year study of the demography of > 1000 T. macdougallii plants growing on pine and oak phorophtyes in a Mexican montane forest and built integral projection models to test the effects of phorophyte, rainfall and harvest on long-term dynamics.
Results: Projected long-term population growth rates (lambda values) for T. macdougallii were higher on pines than on oaks. Lambda increased as a function of dry season rainfall for T. macdougalii populations on both host tree genera, but the increase was steeper for populations on oaks, likely because the former are deciduous. Harvest had a greater negative effect on populations growing on oaks than on pines and the effect decreased as a function of dry season rainfall.
Conclusions: Harvest can have significant impacts on T. macdougalii populations, and the effects depend on both host tree genus and rainfall. A better understanding of how harvest and host tree identity drives vascular epiphyte populations will be critical for understanding how climate change will affect the persistence of these ecologically, economically and culturally valuable species over the long-term.

O25-02 – S25 *Harvest as herbivory: New developments in theoretical and empirical models*
Tuesday 21 June / 16:00-17:30 – Antigone1

Improving harvesting practices of non-timber forest products through smarter modelling: the role of individual heterogeneity

MEREL JANSEN[1], MIGUEL MARTÍNEZ RAMOS[3], NIELS ANTEN[2], FRANS BONGERS[1], PIETER ZUIDEMA[1]
[1]Wageningen University, Forest Ecology and Forest Management, 6700 AA, Wageningen, The Netherlands
[2]Wageningen University, Crop Systems Analysis, 6708 PB, Wageningen, The Netherlands
[3]National Autonomous University of Mexico, Research Institute on Ecosystems and Sustainability, 58190, Morelia, Mexico

Recommendations on sustainable NTFP harvesting are generally based on demographic models, but these models do not incorporate differences between individuals. Individual heterogeneity (i.e. persistent differences between individuals within a population) is common among a large variety of organisms, and is known to strongly shape many population level processes like population growth rate. However, to what extent individual heterogeneity influences harvest predictions has rarely been quantified. Furthermore, it has been shown that super-performing individuals (i.e. individuals that persistently perform better than others) are much more important for population growth than others. This knowledge could help in designing schemes for sustainable harvesting from natural populations, e.g. for Non-Timer Forest Products (NTFPs). Heterogeneity among individuals could potentially be used to obtain higher yields by differentially harvesting from individuals that contribute more to population growth than others, but this potential has not yet been explored.
Here, we analyse the extent to which predictions of NTFP yield and population recovery after harvesting can be improved by including individual heterogeneity in demographic models. We did this for Chamaedorea elegans, a tropical rainforest understorey palm species, which leaves are an economically important NTFP. Long-term inter-individual growth variability was quantified using differences in internode length for 830 individuals from a natural population, which were subjected to two defoliation treatments for three years to quantify responses to harvesting. We used integral projection models and transient population dynamics, to quantify yield and transient population growth rate. Differences in response to defoliation between individuals were taken into account. Furthermore, we analysed the extent to which yields can be increased by differentially harvesting super- and poor performers. We did this by performing simulations for a variety of harvest scenarios, using the constructed transient integral projection model. By analysing the potential of using individual heterogeneity to develop smarter harvest models, this study contributes to the development of improved and more sustainable NTFP harvesting practices.

O25-03 – S25 *Harvest as herbivory: New developments in theoretical and empirical models*
Tuesday 21 June / 16:00-17:30 – Antigone1

Drought and herbivory influence the population dynamics of an island endemic shrub, Schiedea obovata

LALASIA BIALIC-MURPHY, OROU GAOUE
University of Hawaii at Manoa, Botany, 96822, Honolulu, USA

Climate projections suggest environmental conditions will increase in inter-annual variability over time, with an increase in the severity and duration of extreme drought and rainfall events. Based on bioclimatic envelope models, it is projected that changing precipitation patterns will drastically alter the spatial distributions and density of plants and be a primary driver of biodiversity loss. However, many other underlying mechanisms, such as boom-and-bust cycles of herbivory pressure, can impact plant vital rates (i.e., survival, growth, and reproduction) and population dynamics. In this study, we combined a classical drought tolerance experiment with integral projection model to elucidate how changing precipitation patterns and temporal variability in herbivory pressure will likely impact the persistence a Hawaii endemic short-lived shrub, Schiedea obovata. To isolate the influence of changing precipitation patterns on plant vital rates, we conducted a control greenhouse experiment and manipulated mean gravimetric soil water content and drought intensity. To evaluate the influence of temporal variability in herbivory pressure on plant dynamics, we used data from a previous field herbivory experiment. Under current environmental conditions, our results project a slow decline in S. obovata population over time. Prolonged drought will have a greater impact on seedling survival and population dynamics, relative to a proportional decrease in daily precipitation. Furthermore, the synergistic impacts of severe drought and herbivory on S. obovata population dynamics will be greater than their independent effects. This study highlights the importance of directly linking complex interactions of multiple environmental stressors given that ecosystems are continually degraded by human induced changes in the environment.

O25-04 – S25 *Harvest as herbivory: New developments in theoretical and empirical models*
Tuesday 21 June / 16:00-17:30 – Antigone1

Seasonal feeding strategies determine population size among savanna herbivores

A. CARLA STAVER[1], GARETH HEMPSON[2]
[1]Yale University, Ecology and Evolutionary Biology, 06511, New Haven, USA
[2]University of the Witswatersrand, Animal, Plant and Environmental Sciences, NA, Johannesburg, South Africa

Large mammal herbivory can strongly affect vegetation structure in savanna, and vegetation in turn can have major impacts on herbivore population sizes, but the feedbacks between herbivore populations and vegetation in savanna systems remain poorly understood. Here, we combine theoretical and empirical approaches to examining how herbivore diets influence herbivore populations sizes, and the implications for herbivore impacts on woody and grass components in savannas. We find that seasonal variation in diet (whether in space or in diet composition) can inflate herbivore population sizes substantially, with major effects on herbivore impacts on vegetation.

O25-05 – S25 *Harvest as herbivory: New developments in theoretical and empirical models*
Tuesday 21 June / 16:00-17:30 – Antigone1

How is combined timber and non-timber forest products harvest possible?

OROU GAOUE
University of Hawaii at Manoa, Department of Botany, 96822, Honolulu, USA

Most studies on sustainable forest products harvest considered either non-timber forest products (NTFP) or timber harvest. In reality, several species in the tropics are often harvested both for timber and NTFP. We developed a simple novel model that incorporates NTFP harvest implicitly through the plant's intrinsic growth rate and timber harvest explicitly through permanent removal of whole plants, with additional synergistic effects on population growth rate. The application of this model yields simple but practical results on the sustainable harvest limits for combined timber and NTFP harvest, and offers practitioners ways of quickly estimating sustainable harvest limits from limited data. We then apply optimal control theory to investigate optimal strategies for NTFP and timber harvest that minimize the cost of harvest while maximizing the revenue to harvesters and the conservation value of harvested stands. We show that life history is a better indicator of species resilience to harvest than lifespan. Overall, harvest rates must be < 40% to ensure optimality. This optimal rate is lower than commonly reported sustainable NTFP harvest rates.

O26-01 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

A spatial-temporal framework to assess tropical forest disturbance

SILVIO FERRAZ[1], CARLA CASSIANO[5], YURI FORTE[5], FELIPE PAULA[2], GABRIEL BREJÃO[4], TOBY GARDNER[3]
[1]University of São Paulo, Forest Science, 13418900, Piracicaba, Brazil
[2]University of British Columbia, Forestry, V6T 1Z4, Vancouver, Canada
[3]Stockholm Environment Institute, Research, 10451, Stockholm, Sweden
[4]São Paulo State University, Animal Biology Graduate Program, 15054000, São José do Rio Preto, Brazil
[5]University of São Paulo, Forest Science Graduate Program, 13418900, Piracicaba, Brazil

Tropical forest is under a highly dynamic landscape, submitted to many natural and anthropogenic processes like forest conversion, logging, degradation and secondary growth. In Brazil, tropical forest is found at different stages of disturbance, from low disturbance in central Amazon to high disturbance in Amazon frontier. Secondary forest also presents different conditions at agricultural landscapes in southeast region, from reserves in parks to small fragments in croplands. Forest patches condition is highly influenced by historical processes of directly on indirectly perturbation. Also, landscape structure context could have influence on physical and biological fluxes, modifying current condition of those forests.

We present a framework to assess direct and indirect influence on forest patches based on land-use historical information and current landscape structure. Multi-scale temporal and spatial aspects are discussed seeking to capture forest dynamics, anthropogenic disturbances and relate them to ecological processes in terrestrial and aquatic environments. Amazon forest assessment study cases are presented in State of Pará and Rondônia, but also results from Atlantic forest remnants assessment are discussed in southeastern agricultural landscapes.

In Amazon, historical analysis showed that current forest disturbance is a result of different processes of deforestation and degradation spatial and temporal dispersed. In this context, large areas of forest are spatial influenced by surrounding disturbances. In agricultural landscapes at southeastern Brazil the age of secondary forest and landscape context are important indicators of ecological condition of forest fragments.

Forest of different ages, forest dynamics processes and current landscape structure together reveals a mosaic of forest patches under different conditions implying a gradient of disturbance on ecological processes and consequently, on ecosystem services. Based on results, we discuss different methods to be considered in a framework to assess forest disturbance based on historical and spatial data currently available, tools and how those indicators could be linked to field ecological data. Financial Support of FAPESP: 2013/22679-5.

O26-02 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Windthrows affect biomass stocks and balance in Central Amazon forests

DANIEL MAGNABOSCO MARRA[1], SUSAN TRUMBORE[1], NIRO HIGUCHI[2], GABRIEL HPM RIBEIRO[2], JOAQUIM DOS SANTOS[2], VALDELY F KINUPP[3], ROBINSON I NEGRÓN-JUÁREZ[4], JEFFREY Q CHAMBERS[4], CHRISTIAN WIRTH[5]
[1]Max-Planck-Institute for Biogeochemistry, Biogeochemical Processes, 07745, Jena, DE
[2]Instituto Nacional de Pesquisas da Amazônia, Laboratório de Manejo Florestal, 69060001, Manaus, BR
[3]Instituto Federal de Educação, Ciência e Tecnologia do Amazonas, Herbário, 69083000, Manaus, BR
[4]Lawrence Berkeley National Laboratory, Climate Sciences, 94720, Berkeley, USA
[5]Universität Leipzig, AG Spezielle Botanik und Funktionelle Biodiversität, 04103, Leipzig, DE

Blowdowns are a major disturbance regime in the Western and Central Amazon. In this vast region, gap formation due to tree mortality associated with blowdowns can change floristic composition and tree species diversity. However, to date, there is no empirical study showing the effects of blowdowns on forest dynamics. We show that blowdowns can persistently affect biomass stocks and balance during forest recovery from disturbance. We studied a forest chronosequence in Central Amazon composed of an old-growth and three disturbed terra firme forests varying in time since the last blowdown event (i.e. from 4 to 27 years). For each disturbed forest, we estimated tree mortality caused by blowdowns applying Spectral Mixture Analysis on Landsat images. We identified tree species (diameter at breast height [DBH] >= 10 cm) and monitored structural attributes (i.e. tree density and DBH) in 596 plots established along transects spanning a 0-70% tree mortality gradient. Each plot was surveyed at least two times. Overall, we recorded ca. 13,000 trees belonging to 359 genera and at least 1,122 species. Blowdowns changed biomass stocks, with reduced values in areas with greatest tree mortality intensity (323.3 ± 255.2 Mg ha-1) (mean ± 95% confidence interval) persisting for at least 27 years. Biomass gain rates 7 years after disturbance (15.5 ± 4.0 Mg ha-1 y-1) were double those found in old-growth forest. Fourteen years after disturbance, pioneer genera made up a greater proportion of biomass stocks and gain. The most important explanatory mechanisms of biomass gain were tree growth, recruitment and resprouting, respectively. Tree mortality intensity was related to subsequent biomass gain, biomass partitioning among successional groups and changes in the relative importance of biomass gain mechanisms. Although these forests seem to be resilient to wind disturbances, our results support that blowdowns have an important role on defining biomass stocks and balance. This study emphasizes the importance of considering large-scale wind disturbance across the landscape in biomass and carbon balance assessments. Currently, large forest blowdowns are not represented in most of the permanent plots monitored across the Amazon.

O26-03 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Prioritizing forest protection, reforestation, and avoided disturbance in the eastern Amazon

JIM THOMPSON[1], JOICE FERREIRA[2], LUIZ ARAGÃO[3], JOS BARLOW[4], ERIKA BERENGUER[4], PEDRO BRANCALLION[5], SILVIO FERRAZ[5], THIAGO FONSECA[6], TOBY GARDNER[7], RACHAEL GARRETT[8], VICTOR HUGO FONSECA OLIVEIRA[9], ALEXANDER LEES[10], GARETH LENNOX[4], JULIO LOUZADA[9], RALPH MAC NALLY[1], NARGILA MOURA[11], SAMIA NUNES[12], LUKE PARRY[4], RICARDO SOLAR[13], IMA VIEIRA[11]
[1]The University of Canberra, Institute for Applied Ecology, Canberra, Australia
[2]EMBRAPA, Land Use Sustainability, 66095-903, Belem, Brazil
[3]INPE, São José dos Campos, Brazil
[4]LANCASTER, Piracicaba, England(5) ESALQ/USP, Piracicaba, Brazil
[6]CECS/UFABC, São Paulo, Brazil
[7]SEI, Stockholm, Sweden(12) Imazon, Belem, Brazil
[8]Boston University, Boston, USA
[9]Federal University of Lavras, Lavras, Brazil
[10]Cornell University, Cornell Lab of Ornithology, Cornell, USA
[11]Museu Paraense Emilio Goeldi, Belem, Brazil
[13]Federal University of Viçosa, Viçosa, Brazil

Maintaining and restoring critical ecosystem processes and ensuring the persistence of native biodiversity in human modified landscapes will require a combination of habitat protection, restoration and rehabilitation. But how should limited resources be allocated to these different conservation activities to achieve the best ecological outcomes at regional scales, while minimizing economic and social costs? Here we address the problem of strategic landscape planning in multiple-use mosaic landscapes of the eastern Amazon. We explore trade-offs among protecting relatively undisturbed primary forest, avoiding degradation and restoring degraded primary forest, and rehabilitating forest through passive reforestation and protection of secondary forests. Extensive survey data on bird, invertebrate and tree biodiversity were linked with remote sensing data to model species distributions and biodiversity patterns as well as estimates of above-ground carbon stocks in a range of land-use types and forest conditions. Validated models were used to map habitat values across two municipalities in the eastern Amazon under current and possible future management scenarios The resulting maps were used to explore trade-offs among management actions and to identify priority areas for habitat protection, rehabilitation and restoration, using conservation planning software Zonation. These prioritization analyses identified the most cost-effective balance and spatial configuration of forest protection, restoration and rehabilitation, while accounting for connectivity requirements, relative costs, risks of fire and logging, environmental regulations, and uncertainty in species distributions and other inputs. We find that where restoration imposes significant opportunity and implementation costs efforts to avoid and reverse the degradation of standing forests can deliver greater returns on investment for biodiversity conservation, especially in human-modified landscapes that now dominate so much of the tropics. Systemic planning of management options at regional scales can substantially improve expected biodiversity outcomes while minimizing costs and risks, and provide valuable information for regulators, conservation practitioners and landowners in this biologically unique region.

O26-04 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Extinction debt on reservoir land-bridge islands

ISABEL L. JONES[1], NILS BUNNEFELD[1], ALISTAIR S. JUMP[1], CARLOS A. PERES[2], DAISY H. DENT[1]
[1]University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, UK
[2]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

Background: Over 58,000 large dams operate globally, and are increasingly developed in high carbon- and conservation-value habitats such as the Brazilian Amazon. Inundation of terrestrial landscapes during reservoir filling can create land-bridge islands that retain remnant communities of formerly continuous habitat. Biological communities inhabiting reservoir islands are subject to a range of synergistic environmental factors such as area- and edge-effects, driving changes in species richness and community composition. Reservoir islands are often proposed for species conservation in dam development policies, to help mitigate some of the detrimental impacts associated with flooding terrestrial habitats. However the degree of species retention on islands, and hence, whether islands are effective for long-term conservation is unknown. We ask (1) do species on reservoir islands experience an extinction debt, i.e. compared to continuous habitat, does island species richness decrease with increasing island isolation time? and (2) how does island size, and distance to continuous habitat and other islands relate to patterns of species richness and rates of species loss?
Method: Species richness data for five broad taxonomic groups (mammals, birds, herptiles, invertebrates, and plants) from 252 reservoir islands (size <1-1690ha; isolation time <1-92 years) and 84 mainland control sites from nine dams in South America, Central America and Asia were analysed using linear mixed effects models; the influence of isolation time, island area, and distance on patterns of species richness were assessed.
Results: Taxa inhabiting reservoir islands exhibit extinction debt in <100 years of isolation; island area mediates the rate and magnitude of species loss, but even the largest islands show depauperate species richness compared to mainland continuous habitat. Distance to mainland or other islands did not influence island species richness.
Conclusion: Extinction debt is evident across all taxonomic groups and dams studied, and enhanced conservation measures for existing reservoir island communities are therefore needed. Long-term degradation of tropical tree communities on reservoir islands could lead to additional and unaccounted-for carbon loss from tropical dams. Environmental licensing assessments as a precondition for future dam development should explicitly consider the long-term fate of island communities when assessing biodiversity loss vs energy output.

O26-05 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Small rivers, big impacts: environmental disturbances to aquatic biodiversity in Eastern Amazon

LEAL CECILIA[1], LEITÃO RAFAEL[2], CAMPOS VIVIAN[2], OLIVEIRA-JUNIOR JOSÉ MAX[3], SILVA KARINA2, BRITO JANAINA[2], JUEN LEANDRO[4], POMPEU PAULO[5], BARLOW JOS[6], FERREIRA JOICE[7], ZUANON JANSEN[2], HAMADA NEUSA[2], HUGHES ROBERT[8], KAUFMANN PHILIP[9], ROSSETTI FELIPE[10], FERRAZ SILVIO[11], THOMPSON JIM[12], MAC NALLY RALPH[12], GARDNER TOBY[13]
[1]Museu Paraense Emílio Goeldi, Zoologia, 66077830, Belém, Brazil
[2]Instituto Nacional de Pesquisas da Amazônia, Biodiversidade, 69067375, Manaus, Brazil
[3]Universidade Federal do Oeste do Pará, Instituto de Ciências e Tecnologia das Águas, 68035110, Santarém, Brazil
[4]Universidade Federal da Pará, Ecologia, 66075110, Belém, Brazil
[5]Universidade Federal de Lavras, Ecologia Aplicada, 37200000, Lavras, Brazil
[6]Lancaster University, Lancaster Environment Centre, LA14YW, Lancaster, Unitedd Kingdom
[7]Embrapa Amazônia Oriental, Pesquisa e Desenvolvimento, 66095903, Belém, Brazil
[8]Amnis Opes Institute and Department of Fisheries & Wildlife, Oregon State University, OR 97701, Corvallis, United States
[9]U.S. Environmental Protection Agency, Office of Research and Development, OR 97333, Corvallis, United States
[10]University of British Columbia, Faculty of Forestry, V6T 1Z4, Vancouver, Canada
[11]Escola Superior de Agricultura Luiz de Queiroz, Ciências Florestais, 13418900, Piracicaba, Brazil
[12]The University of Canberra, Institute for Applied Ecology, ACT 2617, Bruce, Australia
[13]Stockholm Environment Institute, Stockholm Environment Institute, 10451, Stockholm, Sweden

Background: Land use change and forest degradation are resulting in pervasive changes to tropical ecosystems around the globe. However the consequences for freshwater ecosystems remain poorly understood. This is especially true for the world´s largest watershed, the Amazon basin; and in particular for the complex network of low-order streams that make up the vast majority of its watercourses and host an impressive biodiversity. Here we investigate taxonomic and functional responses of fish and macroinvertebrates assemblages to different anthropogenic disturbances in the deforestation frontier of the Brazilian Amazon.
Methods: We studied 99 low-order streams encompassing five river basins in two large regions (Santarém and Paragominas, both with more than 1 million ha) composed by a diverse mosaic of land uses in the human-modified eastern Amazon. High resolution satellite images were used to access landscape anthropogenic disturbances at different spatial scales.
Results: We sampled a total of 143 fish species, 134 Odonata species and 59 EPT (Ephemeroptera, Plecoptera and Trichoptera) genera. Streams appeared to be exceptionally heterogeneous in their biotic composition, as indicated by the high beta diversity and species turnover between sites, both for fish and EPT assemblages. We found mixed responses from the aquatic biota regarding the importance of different disturbances. For instance riparian forest cover was a major driver of dragonfly assemblage structure. Whereas fish functional richness, evenness and divergence were negatively impacted by the density of road crossings; suggesting that losing regional connectivity potentially contributes to a functional homogenization of local assemblages.
Discussion: Overall our findings underscore the importance of multiple land use changes and disturbances, at different spatial scales, in shaping aquatic assemblages in tropical forests. We particularly highlight the importance of some landscape disturbances often unrecognised, such as road crossings and agriculture intensification that can have a marked effect on streams. We draw on the relationships observed in our data to suggest priorities for the improved management of stream systems in the multiple-use landscapes that characterise so much of the human-modified tropics.

O26-06 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Legacies of human history in Amazonian forests

CAROLINA LEVIS[1], FLAVIA COSTA[2], FRANS BONGERS[3], MARIELOS PEÑA-CLAROS[3], HANS TER STEEGE[4], CHARLES CLEMENT[5], ANDRE JUNQUEIRA[6], EDUARDO NEVES[7], EDUARDO TAMANAHA[8], ATDN NETWORK[4]
[1]Instituto Nacional de Pesquisas da Amazônia, Graduate Program in Ecology, 69080-971, Manaus, Brazil
[2]Instituto Nacional de Pesquisas da Amazônia, Biodiversity Coordination, 69080-971, Manaus, Brazil
[3]Wageningen University, Forest Ecology and Management Group, 6700 AA, Wageningen, Netherlands
[4]Naturalis Biodiversity Center, Biodiversity Dynamics Group, 2333 CR, Leiden, Netherlands
[5]Instituto Nacional de Pesquisas da Amazônia, Technology and Innovation Coordination, 69080-971, Manaus, Brazil
[6]Wageningen University, Soil Quality Group, 6700 AA, Wageningen, Netherlands
[7]Universidade de São Paulo, Museum of Archaeology, 05508-900, São Paulo, Brazil
[8]Instituto Mamirauá, Social Organization Group, 69553-225, Tefé, Brazil

Background: Human societies are constantly transforming the environment where they live. In Amazonia, legacies of past human interventions are still evident even centuries after the demographic collapse of indigenous populations. However, the extent and degree to which forests were transformed is still unknown. More seasonal forests and those closer to rivers are thought to have been more modified than wetter and less accessible forests.
Method: Here we combine more than a thousand forest plots with the location of archaeological sites and maps of navigable rivers across Amazonia to test if human intervention explains the distribution of arboreal (tree and palm) species with some evidence of domestication. Human intervention often consists of a landscape domestication process, in which humans transform the structure and composition of a forest (or landscape) to increase the abundance of useful plants, some also selected.
Result: In all forest plots, we found 85 useful plants with evidences of domestication (hereafter domesticated species). Of those, 20 are considered hyperdominant species of the Amazonian Flora because they represent approximately half of all Amazonian arboreal species. When comparing different geological regions, we found much higher proportions of domesticated species in South-western and Eastern Amazonian forests. In these two regions, proximity to human settlements positively affects the abundance and richness of domesticated species. Moreover, we found that the probable origin of domestication of some species did not match with the location where these were most abundant, suggesting long distance dispersal of domesticated species across the Amazonia.
Discussion and conclusion: Our results indicate an intensive history of domestication by native peoples, especially across the Southwestern and Eastern Amazonian forests. Forests once thought virgin can actually contain varied legacies of ancient human occupation that can be detected by the distribution of domesticated plants. We show that almost one fourth of all domesticated species are hyperdominants, which highlights their importance not only for contributing to reveal human history in this vast tropical forest, but also their potential for socio-economic benefits for the people who live there today.

O26-07 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Agricultural intensification and forest degradation in riverine Amazonia

CATARINA JAKOVAC[2], LOIC DUTRIEUX[3], SITI LATIFAH[3], MARIELOS PEÑA-CLAROS[1], RITA MESQUITA[2], THOMAS KUYPER[1], FRANS BONGERS[1]
[1]Wagneningen University, Forest Ecology and Forest Management Group, 6700 AA, Wageningen, The Netherlands
[2]National Institute for Amazonian Research, Environmental Dynamics, 69083-000, Manaus, Brazil
[3]Wageningen University, Laboratory of Geo-Information Science and Remote Sensing, 6700 AA, Wageningen, The Netherlands
[4]Wageningen University, Department of Soil Quality, 6700 AA, Wageningen, The Netherlands

Secondary forests are becoming increasingly important in Amazonian landscapes. These forests play an important role in carbon sequestration and biodiversity and soil conservation. Nevertheless, the recovery rate, diversity level, and floristic composition of SF are strongly dependent on past and current land use practices. Hence, to assess the real value of SF as ecosystem services providers it is essential to address land use dynamics and related socio-economic drivers.
In this study we aimed to identify the extent and quality of SF in a shifting cultivation landscape in the region of the middle-Amazon river in Brazil, and to relate it to socio-economic changes. First, we inventoried the vegetation of 38 SF patches located along gradients of land-use intensity. Secondly, we applied a novel remote sensing technique, the breakpoint-detection algorithm (BFAST) to Landsat time-series over three decades (from 1984 to 2013), to quantify the number of slash-and-burn events each field has undergone (number of cycles) and the time interval between two of these events (age of SF). Third, we applied interviews to learn about farmers perceptions on land-use changes.
Our results showed that repeated slash-and-burn cycles within a short fallow period regime reduces the recovery rate and species richness of SF and change its floristic composition. SF that experienced more than 4 slash-and-burn cycles show worrisome low recovery capacity and can be considered degraded. Remote sensing time-series showed that the expansion of SF have slowed down over time, and its age has decreased (from 9 to 5 years on average) due to an increase in the frequency of slash-and-burn cycles. The landscape is currently dominated (80%) by young SF with less than 10 years old and 20% of it has already been over-exploited (> 4 cycles). Over-exploited land is mainly located within 1 km from villages.
The identified changes in land use dynamics were associated to constraints of land accessibility, increased concentration of people in villages and market orientation for manioc flour. Our findings show how socio-economic drivers determine the location, stability and quality of SF in the landscape and how public policies for agricultural intensification of shifting cultivation might be inducing land and SF degradation. Understanding land use dynamics can support land-use planning policies and improve estimations on the potential of these landscapes to provide ecosystem services.

O26-08 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
Tuesday 21 June / 10:00-12:00 – Antigone3

Legacies of Amazonian anthropogenic soils and of recent management practices on forest structure and floristic composition

ANDRÉ JUNQUEIRA[1], TJEERD-JAN STOMPH[2], CONNY ALMEKINDERS[3], CHARLES CLEMENT[4], PAUL STRUIK[2]
[1]Wageningen University, Department of Soil Quality, 6708PB, Wageningen, The Netherlands
[2]Wageningen University, Centre for Crop Systems Analysis, 6700AK, Wageningen, The Netherlands
[3]Wageningen University, Knowledge, Technology and Innovation Group, 6700EW, Wageningen, The Netherlands
[4]Instituto Nacional de Pesquisas da Amazônia, Coordenação de Tecnologia e Inovação, 69067375, Manaus, Brazil

Amazonian Dark Earths (ADE) are anthropogenic soils created by pre-Columbian populations mainly between 2,500 and 500 years before present. Besides improving our understanding of past human impacts in Amazonia, ADE have also inspired the development of sustainable agriculture through soil management practices, given their enhanced and long-lasting nutrient and carbon stocks. These soils are widespread throughout the Amazon basin, and today they are used by local people for several forms of plant cultivation and management. Combining interviews with soil sampling and vegetation inventories in Central Amazonia, we looked at farmers' knowledge, management and cultivation practices associated with ADE and adjacent soils, and the resulting agrobiodiversity and land-use patterns. We show that farmers recognize different soil-plant relationships on different soils, leading to different decisions concerning plant cultivation and management. Fertile soils are associated with more intensive cultivation practices, with shorter cycles and higher labour requirements, and also with distinct assemblages of crop species and landraces. Despite the more intensive use of ADE, the use of these soils does not necessarily reduce pressure on surrounding forests, since farmers often combine intensive cultivation on ADE with the typical long-fallow shifting cultivation on poorer soils. Moreover, we identified cases in which the use of ADE followed conventional intensification pathways, leading to the degradation of soils and of the cultivation systems as a whole. Our results show that pre-Columbian soil transformations can influence present knowledge, cultivation practices and agrobiodiversity patterns. ADE add considerable heterogeneity to the soil landscape, providing farmers with increased opportunities to intensify and diversify their cultivation systems. The current use of these anthropogenic soils by smallholder farmers indicates that management practices aiming to increase soil heterogeneity can foster sustainable agriculture, but it cannot be assumed that the enhancement of soil fertility per se will favour sustainable cultivation practices.

O27-01 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Are we heading towards fruit-less forests? Quantitative signatures of change in reproductive cycles of African forests.

EMMA BUSH[1], NILS BUNNEFELD[1], KATHRYN JEFFERY[2], CAROLINE TUTIN[1], LEE WHITE[2], ALISTAIR JUMP[1], DAISY DENT[1], EDMOND DIMOTO[2], JEAN-THOUSSAINT DIKANGADISSI[2], KATHARINE ABERNETHY[1]
[1]University of Stirling, School of Natural Sciences, FK9 4LA, Stirling, UK
[2]Agence Nationale des Parcs Nationaux, ANPN, BP 20379, Libreville, Gabon

Changes in phenology are an inevitable result of climate change, and will have wide-reaching impacts on species, ecosystems, human society and even feedback onto climate. Climate predictions for west tropical Africa include up to seven degrees warming and changes in precipitation and drought intensity in the next century under a "business as usual" scenario". This will influence tropical forests in a variety of ways; in the short-term we can expect to see changes in reproductive phenology of tree species that are reliant on climate cues for phenophase initiation.
Using 30 years of continuous reproductive phenology data (>1400 individual trees of >80 species) and local weather data collected at Lopé National Park, Gabon, we demonstrate, not only the diversity of phenology strategies found in tropical forests and their likely climatic cues, but also test for changes in predictability of regular events (i.e. cycles over time) using Fourier analysis with a moving-window approach. We used power analyses of both simulated and field data to show how temporal sample size and noise derived from both observation and process uncertainty impact detectability of cycles amongst tropical trees.\
We find that the forest at Lopé is dominated by annual reproductive strategies and that a subset of species shows reductions in reproduction, and predictability of reproduction, over time, indicating that certain climate-sensitive thresholds may have already been breached. We show that data length and noise both impact detection of cycles; species in our sample vary widely in time needed before regular reproductive cycles can be confidently detected, from seven years of monthly observations for our least noisy species, to 20 years or more.
Successful adaption of forest management to climate change first requires understanding of vulnerability but currently, phenology of central African forests (e.g. how many species follow regular and predictable cycles, how climate effects predictability etc.) is poorly understood. There are now a number of long-term phenology datasets from the tropics from which insights into current regional and global changes may be gained. Emphasis needs to be placed on species with relatively low noise to cycle ratios that can act as likely "indicators" of change and can be used to monitor forest response in the immediate future and quantitative methods that can improve predictions of plant responses to environmental change.

O27-02 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Identifying triggers of general flowering in a tropical lowland forest in Borneo

MASAYUKI USHIO
Ryukoku University, Joint Research Center for Science and Technology / Department of Environmental Solution Technology, 520-2194, Otsu, Japan

General flowering, one of the most fascinating phenomena in tropical biology, is a community-wide masting phenomenon unique to aseasonal dipterocarp forests in SE Asia. As general flowering has substantial influences on crop yield and reproductive status of forests, ecologists have studied proximate causes of the general flowering for decades. Long-term phonology census suggested changes in rainfall and/or air temperature associated with El Niño Southern Oscillation are correlated with the general flowering. However, as correlations usually do not imply causations, proximate causes of the mass flowering are still poorly understood. In this study, I applied recently developed statistical techniques, convergent cross mapping (CCM) and multivariate S-map, in order to detect causal drivers of the general flowering in Borneo tropical forests.
In a tropical lowland forest in Lambir National Park in Sarawak, Borneo, reproductive activities of plant individuals were monitored since 1993. Approximately 440 plant individuals of 230 species have been monitored twice a month (40 species are Dipterocarpaceae). Plant phenology (i.e., the number of flowering tree individuals) and meteorological data (Southern Oscillation Index [SOI], daily mean temperature and rainfall) were used for the time series analysis. To identify drivers of the general flowering, I applied CCM to the time series. In addition, multivariate S-map method was applied to quantify the influences of causal variables.
CCM showed that air temperature and rainfall had causal influences on the number of flowering trees in the forest while SOI did not have causal influences. CCM also showed that the influence of air temperature and rainfall is three-month and two-month delayed, respectively. Multivariate S-map method suggested that both of air temperature and rainfall negatively influenced the number of flowering trees. Air temperature below 26C strongly triggered the general flowering, while there is no clear threshold of rainfall that triggered the general flowering.
The result indicated that temperature and rainfall triggered the general flowering in accordance with the previous studies. In addition, two- to three-month time-delay seems to be reasonable for trees to respond the environmental variables. The results suggested that changes in air temperature and rainfall associated with recent climate changes would result in changes in the magnitude and frequency of the general flowering in Borneo.

O27-03 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Effects of ENSO and spring frost on flower and seed production in a subtropical rain forest

I FANG SUN[1], CHIA-HAO CHANG-YANG[2], CHENG-HAN TSAI[3], CHIA-LING LU[4], CHANG-FU HSIEH[5]
[1]National Dong Hwa University, Natural Resources and Environmental Studies, 97401, Hualien, Taiwan
[2]Tunghai University, Biological Science, 40704, Taichung, Taiwan
[3]National Taiwan University, Institute of Oceanography, 10617, Taipei, Taiwan
[4]National Taiwan University, Institute of Ecology and Evolutionary Biology, 10617, Taipei, Taiwan
[5]National Taiwan University, Institute of Ecology and Evolutionary Biology, 10617, Taipei, Taiwan

Background: Flower and seed production of plants can be greatly influenced by both natural climatic oscillations and local weather extremes. However, owing to the rarity of long-term monitoring studies conducted at a sufficient temporal scale to capture climatic oscillations and the unpredictability of extreme weather events, evidence that demonstrates how these two external forcings act in concert to drive plant reproduction remains scarce. In addition, considerable variation in species' phenological responses to the external climatic forcings was often observed. Phylogenetic relationships may mediate this inter-specific variation, but previous studies yielded inconsistent results when testing this hypothesis.
Method: We monitored the flower and seed production in a subtropical rainforest, Fushan, Taiwan (24°45'N, 121°35' E), for over ten years (since September 2002). In March 2005, a record low temperature (-1.3°C) occurred at Fushan and caused great frost damage to plants. We used weekly phenological records and long-term meteorological data to assess the effects of climatic fluctuations and extreme weather event on plant reproductive output.
Results: We show that the El Niño Southern Oscillation (ENSO) indices which integrated local climatic variables at Fushan over several months, were strongly associated with flower and seed production. The 2005 spring frost also had long-lasting effects on the flower and seed production of several species. In particular, we detected phylogenetic signals in the relationships between phenological responses of flowering production and several climatic variables (maximum temperature, irradiance, and ENSO34 index). By contrast, the relationships between seed production and climatic variables, as well as phenological responses to the frost event, did not exhibit a phylogenetic signal.
Discussion/Conclusion: Our findings add to the growing evidence that together the natural climatic oscillation (ENSO) and the extreme weather event (frost) determined the temporal variation in flower and seed production. In addition, phylogenetically closely related species resembled each other in their flowering responses to abiotic variation in this subtropical rainforest. Improved understanding of these abiotic and biotic interactions may help predicting population- and community-level phenological responses under future climate changes.

O27-04 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Plant reproductive output altered by selective logging has profound effect on forest regeneration in lowland dipterocarp forests

YU-YUN CHEN[1], I-FANG SUN[1], CHRISTINE FLETCHER[2], S. JOSEPH WRIGHT[3]
[1]National Dong Hwa University, Natural Resources and Environmental Studies, 97401, Hualien, Taiwan
[2]Forest Research Institute, 52109, Kepong, Selangor, Malaysia
[3]Smithsonian Tropical Research Institute, 0843–03092, Apartado, Balboa, Republic of Panama

Regeneration is strongly seed-limited in many tropical forests. Heavy timber extraction altered population and community structure and the potential seed sources of tropical forests. Selective logging, an approach implemented in the tropics for decades, extracts most large timbers above designated sizes and preserve young trees and a few mother trees in each rotation cycle. The design was meant for an improvement for sustainable timber production and forest management. However, the approach greatly alters community structure and neglects the long-term effect of loss of large individuals. To understand the potential effect of structural change on forest regeneration due to selective logging, we investigate seed production, seed survival and seedling establishment of dipterocarp species in a lowland rainforest of Malaysia. We investigated size-dependency of reproductive effort in the dipterocarp species. We then compared rates of seedling establishment in relation to the magnitude of flowering events. Finally, we discussed whether a logged-over forest could match the reproductive output needed for seedling establishment. Our study showed that both flowering probability and frequency were size-dependent such that large trees were more likely to flower and tended to flower more frequently. The total reproductive output of large trees (diameter at breast height (DBH)≥60cm) was 1.22 to 2.75 times higher than smaller trees. We found that seed output is large enough to enable establishment of seedling cohorts only during strong events. In the hypothesized logged-over community, where all adults remained were assumed to produce seeds in full scale, is able to reach the seed production level of the second largest event in the study. Our study suggests a revision on the management approach of selective logging in the forests of intermittent masting.

O27-05 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
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Sustainable livelihoods"

JESS K ZIMMERMAN, J AARON HOGAN, CHRISTOPHER J NYTCH, JOHN BITHORN
University of Puerto Rico, Department of Environmental Sciences, 00936-8337, San Juan, Puerto Rico

Background: Seasonal and inter-annual fluctuations in global climate are key regulators of reproduction in tropical forests. Global climate phenomena such as El Niño are known to play an important role in regulating inter-annaual variation in tropical forest reproduction. We addressed this issue, as well as the long-term influences of severe hurricanes disturbances, in a long-term record of flowering and fruiting in a Caribbean montane forest.
Methods: Using trap-based phenology data collected fortnightly from 1993 to 2013 from a hurricane-affected (1989 Hugo, 1998 Georges) subtropical wet forest site in northeastern Puerto Rico, we conducted a time series analysis of flowering and seed production. Data were subjected to Seasonal-Trend Decomposition of time series by Loess (STL) and multivariate time series analysis of whole communities and species groups separated by life form. We addressed 1) whether the number of species flowering or fruiting was seasonal in this everwet site; 2) the degree to which inter-annual variation in flower and seed production was influenced by global climate drivers and time since hurricane disturbance; and 3) how long-term trends in reproduction varied with plant life form.
Results: SLT revealed that flowering and fruiting were seasonal in our everwet site. The seasonally de-trended number of species in flower fluctuated over time with no long-term trend while the number of species producing seed varied around a declining trend, one apparently due to the lack of severe hurricane disturbances during the last 15 years of the study. Lagged correlation analyses indicated these patterns were also influenced by Pacific-focused El Niño climate indices as well as Atlantic-oriented indices. Long-term patterns of reproduction in individual lifeforms paralleled the community-wide patterns, with large trees and shrubs exhibiting more sensitivity to hurricane disturbances than small or medium trees. There was no long-term increase in liana or vine reproduction as reported in other neotropical sites.
Conclusions: The results confirmed seasonal flowering and fruiting in our everwet forest as found in an earlier analysis using only the first 10 years of data. The linkage of inter-annual trends in flowering and fruiting to both Pacific and Atlantic basins, combined with the influence the history of hurricane disturbance, suggests that reproduction in Caribbean montane forests integrate complex regional and global influences.

O27-06 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Long-term trends of flowering phenology: how predictable is the species contribution over time?

PATRICIA MORELATO
UNESP, Departamento de Botânica, 13506-900, Rio Claro, Brazil

Background: Studies addressing long-term plant phenology have focus on climatic drivers, shifting trends and the relationship to climate change. However, the variability of species phenological response over time and how the variability may affect the community pattern is still underexplored in tropical highly diverse plant communities. That may be related to the usually independent approach of researchers focusing on species phenology or community phenology and also to the lack of systematic long-term phenological series. The organization of flowering phenology within a tropical forest community directly affects the availability of plant resource for pollinators over time and its predictability will define the maintenance of reliable pollinators and seed dispersers in that specific community. Here I propose to investigate whether the sequence of species flowering within tropical woody vegetations is unchangeable over time or whether shifts on community phenology affects the predictability of the time each species flowers from year to year.
Method: I analyzed two long-term phenology data series from Brazilian cerrado savanna (12 years) at Itirapina, São Paulo state, and from Amazon lowland forest (40 years), Manaus, Amazonas state. I first determined the proportion of species flowering at an annual basis; second I investigated the predictability of species flower at the same time over the years and then compared the degree of predictability of flowering time of each species and between the contrasting communities. Finally, I will analyze the sequence of flowering species every each year and its predictability over time.
Results and discussion: Community flowering patterns were seasonal and highly predictable for both savanna and forest vegetation. The first analyses of species flowering predictability along the years showed that there is a proportion of species that shows a high degree of predictability and other group which presents lower predictability that may be related to the species sensitivity to annual variability of climatic clues as well as to reduced phylogenetic constraint or phenological plasticity of flowering time. This first investigation on predictability of tropical phenology is relevant for future conservation measures and to understand the availability of resources and maintenance of the diversity of plant-animal interactions on tropical plant communities, especially facing the actual climatic change scenarios.

O27-07 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Comparison of long-term trends of reproductive phenology in the Neotropics: challenges for climate-change forecasting

IRENE MENDOZA[1], PIERRE-MICHEL FORGET[2], L. PATRÍCIA MORELLATO[1]
[1]Universidade Estadual Paulista, Botany, 13506-900, Rio Claro, Brazil
[2]Muséum National d'Histoire Naturelle, Ecology and Biodiversity Management, 91800, Brunoy, France

Background - Changes in plant phenology are compelling indicators of climate change. Previous reviews of phenological patterns in temperate ecosystems have shown consistent trends towards earlier spring advancement or later leaf fall, among others. In the tropics, both the paucity of long phenological series and the lack of strong changes in temperature over the year hinder the extraction of similar trends. Understanding temporal changes in the intensity and length of flowering, fruiting or leaf production is crucial for forecasting plants' responses to ongoing climatic patterns. This study combines two existing long-term datasets of phenological monitoring in the Neotropics with two main objectives: first, to analyze long-term phenological responses to climate and second, try to predict their trend under climate change. The challenge of this purpose is the use of a modelling approach that includes species-specific descriptors of patterns of plant phenology at each site integrated with appropriate climatic descriptors
Method - We used two long-term phenological series from an Amazon rainforest (Nouragues, French Guiana) and a Brazilian cerrado (Itirapina, Sao Paulo State), although other series are intended to be used in the future. We used a hierarchical Bayesian approach to evaluate variation of seed production for each studied species. Our model calculated parameters for both the timing and intensity of flower and fruit production. Changes in phenological trend over time were tested with linear models.
Results and discussion - Phenological trends were equivocal, with some species showing a clear increase or decrease over time, but without a marked pattern of the two studied sites at the community level. These results contrast with a previous work that found an increase of flower and fruit production of liana species in BCI over time. The inclusion of more phenological datasets and the refinement of the models appear as possible improvements of this ongoing research. The resolution of trends of phenological change in the tropics has relevant applications for forest management and biodiversity conservation, as they will show the differences in sensitiveness to climate among species and types of vegetation, and the availability of resources for animal consumers.

O27-08 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Impacts of global change on the phenology of African ecosystems

GABRIELA S. ADAMESCU[1], COLIN BEALE[1], ANDREW PLUMPTRE[2]
[1]University of York, Biology, YO10 5DD, York, United Kingdom
[2]Wildlife Conservation Society, Albertine Rift Program, PO box 7487, Kampala, Uganda

Background: Currently, the Earth is entering an era of a rapid global warming. Changes in phenology, the timing of biological events, are widely studied in temperate regions. However, little is known about potential shifts in tropical phenology, where temperature is not usually limiting. Phenology has been challenging to address because of tropical forests' complex ecosystems and relative paucity of data. Current knowledge about tropical phenology mainly originates from Asia and South American studies, where leafing, flowering and fruiting have all been related to rainfall patterns, but little consistent change has been identified. In this study, we assess phenology in 12 forests from across Africa, identifying seasonal patterns and climate driven changes.
Methods: We use data from around 6000 individuals of 200 tree species in 12 tropical forests across East, Central and West Africa, each with data gathered monthly on flowering and fruiting events, collected between six and 24 years. Using Fourier analysis, we identify site and species differences in the dominant cycle length, the timing and the predictability of individual tree phenology. We assess how these same parameters have changed in recent years using time-series analysis. We further analyse inter-annual variation in the canopy-level fruiting and flowering patterns in relation to large scale climatic processes (ENSO, etc) and direct weather measures.
Results: Cycle length, seasonal phase and predictability in timing of individuals of the same species differ between sites. Across all sites, species tend to flower less often over time and predictability of flowering by individual trees is decreasing. We found weak and species-specific correlations between weather and canopy-level phenological indicators for several species across the continent.
Discussion: Our results suggest that African tropical forests may be experiencing changes in phenology in response to recent climate change. However, simple comparisons with temperate systems are inappropriate: rather than consistent canopy level changes in seasonality, the predictability of cycle length of individual trees appears to be changing, resulting in inconsistent canopy-level patterns. Canopy level phenology may be expected to change in different ways across the continent with no simple story appropriate for many species in many locations.

O27-09 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

The environmental regulation of flowering times in tropical moist forests

S. JOSEPH WRIGHT[1], OSVALDO CALDERÓN[1], HELENE MULLER-LANDAU[1], YU-YUN CHEN[2], I-FANG SUN[2], AKIKO SATAKE[3]
[1]Smithsonian Tropical Research Institute, na, Apdo 0843–03092, Balboa, Panama
[2]National Dong Hwa University, Natural Resources and Environmental Studies, 97401, Hualien, Taiwan
[3]Kyushu University, Biology, 819-0395, Fukuoka, Japan

Background: The timing of flowering depends on an environmental trigger or proximal cue and might be modified by additional environmental factors. The environmental triggers and modifying factors that determine flowering times in tropical forests are largely the subject of conjecture. Low and high temperatures, drought and rain, day length, maximum solar irradiance, and daily solar insolation at the forest canopy and at the top of the atmosphere have all been hypothesized to act as flowering cues.
Methods: We evaluate all of these hypotheses in a model selection framework against long-term flower records from moist tropical forests at Barro Colorado and San Lorenzo, Panama and the Pasoh Forest Reserve, Malaysia. Our flower records begin in 1987, 1997 and 2001 and include species-level identification of all flowers collected in weekly censuses of 200, 40 and 336 litter traps, respectively. Our meteorological data include hourly temperature, rainfall, relative humidity and solar irradiance.
Results: Drought and low temperatures act synergistically to cue general flowering in Shorea (Dipterocarpaceae) at Pasoh, but do not cue flowering in Panama. Rain following seasonal drought cues flowering in 14% of the Panamanian species evaluated. Preliminary analyses indicate that vapor pressure deficits and solar insolation at the forest canopy affect flowering times in many more Panamanian species.
Discussion: Our analyses provide the first quantitative estimates of the levels, duration and seasonal timing of the environmental cues that trigger and modify flowering in tropical forest trees. We hope to replace the current qualitative understanding of the phenology of tropical forest trees with quantitative insights that will enable successful prediction of phenological responses to natural and anthropogenic climate variation.

O27-10 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
Tuesday 21 June / 14:30-17:30 – Antigone3

Long term phenology of a tropical montane forest: 18 years of fruiting and flowering in Nyungwe National Park, Rwanda

BETH KAPLIN[1], FELIX MULINDAHABI[2], JEAN-BAPTISTE GAKIMA[2], FERDINAND NGAYABAHIGA[2], ERASTE NZAKIZWANAYO[2]
[1]Antioch University New England and University of Rwanda, Environmental Studies, 05346, Keene, NH and Butare, USA and Rwanda
[2]Wildlife Conservation Society, Rwanda Country Office, 00000, Gisakura, Rwanda

Tropical montane forests are relatively understudied compared to their lowland counterparts, and Afromontane tropical forests are particularly understudied. In the Albertine Rift these forests are home to many endemic and endangered or threatened plant and animal species including frugivores such as chimpanzees, monkeys, bats and birds. These species provide important services including seed dispersal and tourism support. With climate change and loss of much of the lower elevation forest cover within Afromontane forests, understanding fruit phenology patterns over time and how these patterns may influence populations of frugivores is crucial. Here we present data from 850 individuals from 59 tree species in a phenological study over an 18 year period. Trees were sampled once per month and phenology was recorded using a scoring system (0-4). We found overall forest fruiting peaks started during the main rainy season and extended into the main dry season (March – July/August) but during El Nino phases this peak did not occur. The proportion of the sample in fruit each year was significantly greater during non El Nino phases. We also found variation in fruit availability across elevational gradients. Finally, we identified tree species whose fruits were available when overall forest fruit abundance was low, including Ficus species. These variations have implications for inter-forest migration patterns and for frugivore population resilience in the face of climate change.

O28-01 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Space use and directness to out-of-sight resources in semi-provisioned and wild-feeding groups of Macaca leonina

MARIE-CLAUDE HUYNEN[1], TOMMASO SAVINI[2], AURÉLIE ALBERT-DAVIAUD[3], NORBERTO ASENSIO[4], JUAN MANUEL JOSE DOMINGUEZ[5]
[1]University of Liège, Behavioal Biology Unit, 4020, Liège, Belgium
[2]KMUTT, Conservaiton ecology program, 10150, Bangkok, Thailand
[3]Royal Botanic Gardens, Comparative plant and fungal biology, RH17 6TN, Kew, UK
[4]Mahidol University, Faculty of Environment and Resource Studies, 10150, Bangkok, Thailand
[5]University of Granada University, Laboratory of Anthropology. Department of Legal Medicine, Toxicology and Physical Anthropology. 18016, Granada, Spain

Space-use patterns provide information on how animals find their resources (food, sleeping sites and mates) within spatio-temporally changing habitats. This information is crucial to understand the ecology and evolution of animal species and, in recent time, became highly important in drafting effective conservation actions. However, due to the complexity of the topic, we are still lacking detailed space-use data for most primate species, as well as on how human disturbance affects this aspect of their ecology. We present data on the movement patterns of two troops of northern pigtailed macaque (Macaca leonina) living in the pristine evergreen old growth forest in Khao Yai National Park, central Thailand. One troop (CH, 67individuals) is wild-feeding and one (HQ, 39 individuals) partially provisioned by tourists. HQ troop has a smaller home range, with human food resources quite predictable both in location and amount, while CH troop has a larger home range with resources' spatio-temporal changes. Based on this difference in predictability, we expect more directional changes in the HQ troop daily movement, associated to both food resources and sleeping sites, than in the CH troop. Over a period of 12 months, we followed the CH troop for 80 days and the HQ troop for 86 days, using 30 minute scan sampling method. We investigated the travel routes between feeding areas and sleeping sites in regard to direct traveling and detectability, applying change point analysis of travel routes. Our results showed that directional changes were associated to food resources and, in the last hours of the day, to the location of the selected sleeping sites for both troops. However, for the CH troop, we found a weaker correlation between feeding areas and directional changes than in the HQ troop. Moreover, although directional changes were associated to sleeping sites for both troops, in CH, these changes were also associated to the last feeding area, while for HQ they were only occasionally associated to wild food as well. We suggest that both food resources and sleeping sites are important factors leading daily macaque's movement, but the movement pattern of the wild-feeding CH also seems to include more chance component. Our findings reinforce the idea that conservation programs should not only focus on habitat protection based on adequate food resources, but also on others habitat features such as places providing an optimal refuge during the sleeping periods.

O28-02 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Primates adjust movement strategies with food availability

RAFAEL REYNA-HURTADO[1], JUIE TEICHROEB[2], TYLER BONNELL[3], RAUL HERNÁNDEZ-SARABIA[4], SOFIA VICKERS[5], JUAN CARLOS SERIO-SILVA[6], PASCALLE SICOTTE[7], GUILLERMOS CASTILLO-VELA[1], COLIN CHAPMAN[8]
[1]El Colegio de la Frontera Sur, Conservación de la Biodiversidad, 24500, Campeche, Mexico
[2]University of Toronto Sacrborough, Department of Anthropology, M1C1A4, Toronto, Canada
[3]University of Lethbridge, Department of Psychology, T1K3M4, Lethbridge, Canada
[4]Universidad Veracruzana, Instituto de Neuroetología, 91090, Xalapa, Mexico
[5]University of California Santa Cruz, Department of Anthropology, 95064, Santa Cruz, USA
[6]Instituto de Ecología, Red de Vertebrados, 91070, Xalapa, Mexico
[7]University of Calgary, Department of Anthropology, T2N1N4, Calgary, Canada
[8]McGill University, Department of Anthropology, H3A2T7, Montreal, Canada

Background: For primate species whose food resources tend to be abundant and uniformly distributed, such as those of folivores, the best movement pattern has been classified as randomly-derived (Brownian) (Viswanathan et al. 2011). While, for species whose food resources are rare and patchily distributed, such as those of frugivores, non-Brownian search strategies are proposed to maximize encounter rates with food (Ramos-Fernandez et al. 2004). In this study we asked, what happens to primate movement patterns when food availability and spatial distribution changes over time?
Methods: Ateles geoffroyi yucatanensis and Allouata pigra were studied en Mexico, while Procolobus rufomitratus, Cercocebus albigena and Chlorocebus pygerythrus in Uganda and Colobus vellerosus in Ghana. Observations were done using focal sampling of randomly selected individuals of each troop (Altmann 1974). A GPS fix taken from the center of the troops were recorded every 5 to 15 minutes depending in the species. We examined consecutive step lengths at 5, 10, 15, or 30 minutes respectively, according to the sampling regime followed for each species. We then fit three models to the observed step-length distributions, comparing between power law, exponential, and log-normal models, following the approach outlined by Clauset et al. (2009) and using the poweRlaw package in R (R Core Team, 2013).
Results: Consecutive steps for spider monkeys (n=1133) and grey-cheeked mangabeys (n=2698) indicated that Power-law distributions were supported overall and in all seasons for these species. Vervet monkey movements (n= 1608) supported a Brownian movement pattern during the dry season and the power-law was significantly discriminated. Ursine colobus (n= 1014) movement patterns supported also the Brownian distribution overall and in all seasons. Howler monkeys consecutive steps (n=780) supported a Log-normal distribution overall and during the rainy season, while the Power-law distribution was the best fit model during the dry season. Red colobus consecutive steps (n=7974) supported a Log-normal distribution overall and during the rainy season but a Brownian distribution during the dry season.
Discussion: We demonstrated that some primates modify its searching patterns when food availability changes. Spider monkeys, Howler monkey and Red colobus changed toward a more long-tailed distribution movement patterns from dry to rainy season, Mangabey showed the opposite while Ursine colobus did no changed.

O28-03 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Comparative foraging strategies of Neotropical frugivores: Do primates forage 'smarter'?

MARGARET CROFOOT[1, 2], DAMIEN CAILLAUD[3], RAFAEL MARES[2], ROLAND KAYS[2, 4, 5], BEN HIRSCH[6]
[1]University of California, Davis, Anthropology, 95616, Davis, USA
[2]Smithsonian Tropical Research Institute, n/a, n/a, Panama City, Panama
[3]Dian Fossey Gorilla Fund, n/a, 30315, Atlanta, USA
[4]North Carolina Museum of Natural Sciences, Biodiversity Research Lab, 27601, Raleigh, USA
[5]North Carolina State University, Forestry and Environmental Resources, 27607, Raleigh, USA
[6]James Cook University, Zoology and Ecology, QLD 4811, Townsville, Australia

Background: Due to their extraordinary diversity of fruit-producing trees, tropical forests present a veritable bonanza of high quality food. Making a living as a tropical frugivore, however, poses significant challenges. Fruit is an ephemeral and spatially clumped resource. A medium-sized frugivore's range can contain as many as 100,000 trees, few of which contain food at any given time. In complex environments such as these, the ability to integrate information about what resources are available, where they are located, and when they are ripe dramatically improves frugivore foraging success. It has recently been argued that primates, because of their long coevolutionary history with angiosperms, possess cognitive adaptations for foraging on fruit that allow them to forage more efficiently than other frugivores. However, the comparative data needed to adequately test this hypothesis do not currently exist.
Methods: To test the hypothesis that primates incorporate information about the relative size of food patches into their foraging decisions, we used GPS-collars to track the foraging patterns of four frugivores—capuchins (Cebus capucinus), spider monkeys (Ateles geoffroyi), coatis (Nasua narica) and kinkajous (Potos flavus)— living on Barro Colorado Island (BCI), Panama. During the season of low fruit availability, these frugivores are united by an almost exclusive reliance on a single keystone species, Dipteryx oleifera. This shared motivation creates a common yardstick to compare their foraging strategies. We exhaustively mapped the distribution of D. oleifera trees on BCI using drone-based aerial photography, and determined which trees study animals visited based on their movement patterns. We calculated the surface area of each trees' crown, and used this measurement as a proxy for patch size.
Results: Patterns of movement and foraging behavior differed significantly among the four study species, with spider monkeys showing strong evidence of route-based travel. Discrete choice models suggest that patch size plays a more important role in the foraging decisions of capuchin and spider monkeys than of kinkajous or coatis.
Discussion: Our results suggest that sympatric frugivores may incorporate different types of information into their foraging decisions, even when faced with identical ecological problems. Whether the observed differences in foraging behavior translate into differences in foraging efficiency requires further investigation.

O28-04 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Forest types affect seed shadows by white-handed gibbons

TOMMASO SAVINI[1], SUCHADA PHIPHATSUWANNACHAI[1], ADAM MCKEOWN[2], DAVID A. WESTCOTT[2]
[1]King Mongkut's University of Technology Thonburi, Conservation Ecology Program, 10150, Bangkok, Thailand
[2]CSIRO, Land and Water, 4883, Atherton, QLD, Australia

Gibbons are an important component of the seed disperser community inhabiting the tropical forests of Southeast Asia. For decades they have been considered restricted to old growth evergreen forests. However, recently the increased number of study sites within their range allowed to highlight the presence of the species in the drier, and expected to be of lower quality, mosaic forest of the Western Forest Complex at the border between Thailand and Myanmar. Here we compare the dispersal potential and seed shadow generated by two white-handed gibbons (Hylobates lar) groups inhabiting the old growth evergreen forest and the adjacent mosaic forest (mix deciduous and dry dipterocarp) of HuaiKhaKhaeng Wildlife Sanctuary (western Thailand). In evergreen forest, gibbons are expected to have a smaller home range in which their daily path length (DPL) would generate a higher travel tortuosity with consequent shorter estimated seed dispersal distance. The opposite scenario, larger home range, straighter daily path and larger seed dispersal distance, should be expected for the group inhabiting the mosaic forest. We used scan sampling while following two habituated gibbon groups for five consecutive days over a six month period, ranging over the seasonal change between dry and wet seasons. As predicted the evergreen forest group showed smaller overall HR (12.4ha) but with significantly longer DPL (1507±346m) than the group inhabiting the mosaic forest (20.9ha and 1114±390m). Average tortuosity was higher in the group in evergreen forest (39.1±34.8) than in the one in mosaic forest (16.1±8.3) indicating an intensive reuse of space over the same time by the evergreen forest group. As predicted, direct field observation, based on a sample of particular dispersal events, showed an average shorter dispersal distance from parent tree in evergreen forest (170m) than in mosaic forest (202m). However, contrary to the prediction, the modelled seed dispersal distances, which used measured gut passage time to estimate the range of possible dispersal outcomes from across the movement pathway, was significantly longer in evergreen forest (163m) than in mosaic forest (116m). The difference between the two analytical methods, direct observation and estimation model, could result from the fact that the observed dispersal distances were effectively a sub-sample of the range of possible modelled dispersal distances.

O28-05 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

The ecology of space-use patterns of two sister gibbon species in their contact zone

NORBERTO ASENSIO[1], JUAN MANUEL JOSE-DOMINGUEZ[2], CHALITA KONGRIT[3], WARREN BROCKELMAN[4]
[1]Mahidol University, Faculty of Environment and Resource Studies, 73170, Nakornpathom, Thailand
[2]University of Granada, Laboratory of Anthropology, 18012, Granada, Spain
[3]Mahidol University, Faculty of Science, 10400, Bangkok, Thailand
[4]Bioresources Technology Unit, Ecology laboratory, 12120, Pathum Thani, Thailand

Natural hybrid zones are unique systems that can help understand what factors regulate species coexistence and geographical distributions. Interspecific territoriality has been proposed as a means by which two similar species distribute themselves in a heterogeneous habitat mediating the spatial boundaries at hybrid zones. In addition, overlapping areas between territorial species, such as gibbons, should be underused given the risk of aggression in intergroup encounters. We investigated the spatial patterns of two gibbon species and hybrids co-occurring in a major area of the contact zone in Khao Yai National Park, Thailand. We found a mosaic of segregated home ranges of white-handed gibbons, pileated gibbons, and mixed-species groups, which sometimes included hybrid individuals. This spatial configuration of different groups intermingled throughout the landscape with little overlap regardless of the neighboring species supports the existence of territoriality between the three gibbon forms. However, we did not find strong evidence of overlapping areas being underused by gibbons or being used differently depending of the neighboring species. Instead, the intensity of gibbon space use when moving from the center to the edge of home ranges did not drop as quickly as expected for territorial species, and presented some peaks not clustered at the center of home ranges. Although interspecific territoriality could overall mediate the observed spatial distribution of gibbon groups at the hybrid zone, other factors such as food distribution might have a larger role in the way different areas of the home range are used, including those regions in which neighboring groups overlap. Despite the significance of hybrid zones in community ecology and evolutionary biology, they have received little attention in conservation biology. Most gibbon hybrid zones are already destroyed and the few ones remaining, such as the one between Müller's Bornean gibbon and the Bornean white-bearded gibbon in Borneo, remain understudied.

O28-06 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Influence of food provisioning by humans on locomotion of dusky langur (Trachypithecus obscurus Reid, 1837) at Khao Lommuak, Prachuap Khiri Khan, Thailand

AGGIMARANGSEE NANTIYA
Chiang Mai University, Biology, 50200, Chiang Mai, Thailand

Dusky langur, a colobine, is distributed from Kra Isthmus of Thailand, southward toward the Malayan peninsula. Khao Lommuak is a small (c. 0.5 sq.km), isolated and forested limestone hill located in a Royal Air Force Base-Wing 5, Prachuap Khiri Khan, Thailand. Dusky langur population at this hill is safe due to the restricted area and a sacred spirit. Visitors come here regularly to pay respect the spirit and feed the langur. A Ph.D. study on behavior and ecology of the langur was conducted during May 2001-Sep 2002 to understand their adaptation toward human activities.
Behavioral scan sampling method adapted from Altman (1974) was used to observe daily activities of two focal groups during Aug 2001-Jul 2002. Scan samples were recorded during a 3-minute period every 15 minutes from dawn to dusk on every full day follow. The 50-meter square grids were made to established locations of the landmarks, botanical plots and those of langur during scan observation. Group I was observed 7,397 cases (141 days observed), while Group II was observed 6,944 cases (135 days).
Locomotion engaged during foraging, traveling, seeking resting or sleeping sites, included walking, running, jumping and leaping. Chi-square test indicated that the observed activities of both groups correlate to the grid square (Gr I with 29% contingency coefficient and Gr II with 22%). Gr I covered 23 squares and was most observed in square J8 (c. 16%) and J9 (c. 10%). Gr II covered only 9 squares and was most observed in K9 (35%), K10 (25%), J9 (15%) and K11 (12%). Locomotion of both groups was observed frequently in provisioned squares (Gr I=848/993 observations; Gr II=666/712). However, percentages of locomotion in both groups were higher in unprovisioned squares (Gr I=19.1%, Gr II=14.2%) than in provisioned squares (Gr I=12.8%, Gr II=10.1%). Feeding provisioned foods in both groups was observed in provisioned squares only for c. 4% while feeding natural foods were observed in both square types but higher in unprovisioned squares (Gr I=15.7%, Gr II=20.4%) than in provisioned squares (Gr I=12.8%, Gr II=14.2%). Ranging of both groups was overlapping within J9 where provisioning by humans at the area near the shrine were regularly observed.
Food provisioning distinctively influenced behavior of the dusky langur by attracting them to gather in the provisioned squares, spent lesser time on locomotion and fed more on provisioned foods, therefore, provisioning should be avoided in natural habitats.

O28-07 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Which Factors Shape The Trajectories Of The Black-Lion Tamarins In A Fragmented Landscape?

YNESS MESSAOUDI[1], BERNARDO NIEBUHR[2], KARL MOKROSS[2], GABRIELA REZENDE[3], LAURENCE CULOT[1]
[1]Universidade Estadual Paulista, Zoologia - Laboratório de Primatologia, 13506900, Rio Claro, Brazil
[2]Universidade Estadual Paulista, Ecologia - Laboratório de Ecologia Espacial e Conservação, 13506900, Rio Claro, Brazil
[3]Instituto de Pesquisas Ecológicas, km 47, 12960000, Nazaré Paulista, Brazil

Background: The identification of the social, ecological and landscape factors that shape primate trajectories but also the movement patterns that are associated to specific behavioral phases should enable the modelling of primate space use in different contexts such as human-altered landscapes versus pristine continuous forests. Through the study of one group of black-lion tamarins (BLTs, Leontopithecus chrysopygus), an endangered primate species of which habitat is highly fragmented, we aimed at 1) determining whether and how fragment edges affect their movement patterns; 2) identifying the factors for which BLTs plan their routes; 3) characterizing their movement patterns in terms of velocity and angle variances in different behavioral phases.
Method: We followed one pair of BLTs in Santa Maria fragment (Pontal do Paranapanema, SP, Brazil) during 29 days. We marked the localization of the group and made scan sampling of the pair every 5 min. All feeding events in fruiting or gum tree, resting events, sleeping sites, long calls, and intergroup encounters were localized and registered through the All occurrence sampling method. We used the Change-point Test (CPT) to identify the event associated to a significant change of trajectory and generalized linear models to compare movement patterns according to behavioral phases.
Result: BLTs maintained a distance of 50m and 200m from the sugar cane and road edges respectively but did not show significant changes of angles in their trajectories when approaching the edges. We registered a mean of 4.8 CP (change-point) per day. About 41% of CP were associated to feeding bouts and 28% to vigilance. First results of movement patterns in different behavioral phases show linear paths at low velocities and small relative angles during insect foraging, tortuous paths with large relative angles during feeding phases and high velocities with large relative angles during intergroup encounters.
Conclusions: BLTs behave differently according to the type of edge, avoiding more the road than the sugar cane. Since they plan their daily route mostly in function of fruiting trees and that specific movement patterns are associated to specific behavioral phases, we recommend the incorporation of these factors when modelling primate movements.

O28-08 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Using individual-based models to assess the landscape connectivity for the endangered Golden-Lion Tamarins

BERNARDO B. S. NIEBUHR[1], MILENE A. ALVES-EIGENHEER[1], JOHN W. RIBEIRO[1], ANDREIA M. MORAES[2], BRENDA R. ALEXANDRE[3], LAURENCE CULOT[4], MILTON C. RIBEIRO[1]
[1]Universidade Estadual Paulista, Ecology, 13506-900, Rio Claro, Brazil
[2]Universidade Estadual do Norte Fluminense Darcy Ribeiro, Biosciences and Biotechnology, 28013-602, Campo dos Goytacazes, Brazil
[3]Universidade Federal do Rio de Janeiro, Ecology, 21941-902, Rio de Janeiro, Brazil
[4]Universidade Estadual Paulista, Zoology, 13506-900, Rio Claro, Brazil

Background: Understanding how animals use space and how landscape modifications affect population dynamics and landscape connectivity is a central issue in landscape ecology and conservation biology. Movement may be a particularly important factor that influences these processes, but many other life history traits may interact with movement to explain connectivity, especially for primates, that exhibit complex behavioral patterns. The Golden-Lion Tamarins (GLT, Leontopithecus rosalia) are endangered primates that live in fragmented lowland Brazilian rainforests and have been monitored for more than 30 years. Here we gathered expert knowledge, different kinds of data, and an individual-based modeling (IBM) approach to assess landscape connectivity for GLT populations.
Method: Landscape connectivity was assessed in two ways. First, expert knowledge on matrix resistance to movement was gathered with land cover data and least-cost path analyses were performed. Connectivity was measured as total cost and total distance of least-cost corridors. In a second step, we used BioDIM (Biologically scaled Dispersal Model), an IBM of animal movement in fragmented landscapes, to simulate population dynamics of GLT. The model was fed with data on group movement and GLT life history, and was validated using presence-absence data. Landscape connectivity measures were compared between least-cost and IBM methods.
Result: Expert knowledge indicated high preference of GLT for forested areas. Least-cost path analyses produced corridors linking populations that minimize the cost to movement; however, some of them are not used by GLT, as shown by occupancy data. IBM rules generated realistic paths, and depending on the initial conditions and the parameters chosen, the model could produce a landscape occupancy similar to the observed. BioDIM also represented GLT preference for forest areas, where movement paths were highly tortuous, while in matrix environments, group movement was straighter. A representation of complex behavior of GLTs by the IBM produced more realistic corridors in comparison with least-cost analyses.
Conclusion: Despite the complexity of the method, IBM results demonstrated their advantage in explaining primate movement and population connectivity, in comparison with least-cost methods. However, both methods indicated locations in the landscape that are more important to maintain connections and flow of individuals and genes between populations.

O28-09 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Baboon troop movements and their ecological determinants at local and continental scales

CASPIAN JOHNSON[1], ALEX PIEL[2], DAN FORMAN[1], FIONA STEWART[3], ANDREW KING[1]
[1]Swansea University, Department of Biosciences, SA2 8PP, Swansea, UK
[2]Liverpool John Moores University, School of Natural Sciences and Psychology, L33AF, Liverpool, UK
[3]University of Cambridge, Department of Archaeology and Anthropology, CB2 3QY, Cambridge, UK

Background: How an animal moves through its environment directly impacts its survival, reproduction, and thus biological fitness. A basic measure describing how an individual (or group) travels through its environment is Day Path Length (DPL), i.e., the distance travelled in a 24-hour period. Here, we investigate the ecological determinants of baboon (Papio spp.) troop DPL and movements at local and continental scales.
Results: At the continental scale we explore the ecological determinants of annual mean DPL for 47 baboon troops across 23 different populations, updating a classic study by Dunbar (Behav Ecol Sociobiol 31: 35-49, 1992). We find that variation in baboon DPLs is predicted by ecological dissimilarity across the genus range. Troops that experience higher average monthly rainfall and anthropogenic influences have significantly shorter DPL, whilst troops that live in areas with higher average annual temperatures have significantly longer DPL. We then explore DPLs and movement characteristics (the speed and distribution of turning angles) for yellow baboons (Papio cynocephalus) at a local scale, in the Issa Valley of western Tanzania. We show that our continental-scale model is a good predictor of DPL in Issa baboons, and that troops move significantly slower, and over shorter distances, on warmer days. We do not find any effect of season or the abundance of fruit resources on the movement characteristics or DPL of Issa baboons, but find that baboons moved less during periods of high fruit availability.
Conclusion: Overall, this study emphasises the ability of baboons to adapt their ranging behaviour to a range of ecological conditions and highlights how investigations of movement patterns at different spatial scales can provide a more thorough understanding of the ecological determinants of movement.

O28-10 – S28 *Primates on the move: from local to landscape scale*
Tuesday 21 June / 14:30-17:30 – Rondelet

Social and environmental factors influence local movement decisions in a troop of wild baboons

ARIANA STRANDBURG-PESHKIN[1], DAMIEN R. FARINE[2], MARGARET C. CROFOOT[3], IAIN D. COUZIN[4]
[1]Princeton University, Ecology and Evolutionary Biology, 08544, Princeton, USA
[2]Max Planck Institute for Ornithology, Department of Collective Behavior, 78464, Konstanz, Germany
[3]University of California Davis, Anthropology, 95616, Davis, USA
[4]University of Konstanz, Department of Collective Behavior, 78464, Konstanz, Germany

Background: When deciding where to move, social animals must integrate information about the habitat around them with social factors such as the locations and movements of conspecifics. Yet differentiating the role of social and physical environmental factors in shaping individual movement decisions remains a challenge.
Method: In this study, we combine simultaneous high-resolution GPS tracking data from almost an entire troop of wild baboons with a detailed three-dimensional reconstruction of the habitat to investigate the interplay between social and non-social factors in influencing the fine-scale movement decisions of baboons. Using a step selection framework we quantify the features that are most predictive of where individual baboons choose to move, and use these to visualize the jointly social and environmental "preference landscape" that underlies movement decisions.
Results: Overall, we find that road-following and movement towards and away from the sleep site are important non-social predictors of individual movements, However, the predictive power of social features is even greater: baboons preferentially travel over terrain recently occupied by other baboons (within the past few minutes), but avoid locations that are currently occupied. Our results suggest that as baboons move through their environment, they effectively "pave the way" for their troop-mates, who move to fill their previous spots. The greater the number of troop-mates that have recently occupied a location, the more likely it is that a baboon will move there, resulting in a majority rule. The importance of different social and nonsocial features also varies depending on the time of day, with the sleep site direction and roads becoming much less important during the middle of the day.
Conclusion: Baboons are clearly influenced in their movement decisions by both their social and asocial environment. Combining high-resolution tracking and imagery data with multi-model inference and step selection methods allows us to quantify the importance of each of these factors, as well as how they vary in influence throughout the day. By incorporating social factors into step selection models, our work forges a link between collective behavior and movement ecology, and takes a critical step towards understanding how animal groups move in heterogeneous, natural environments.

O29-01 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Susceptibility of tropical forests to drought: should we expect continents to differ?

ALEXANDER CHEESMAN[1], AMY ZANNE[2], WILL PEARSE[3], WILL CORNWELL[4], LUCAS CERNUSAK[1]
[1]James Cook University, College of Marine & Environmental Science, 4870, Cairns, Australia
[2]Georgw Washington University, Biological Sciences, 20052, Washington DC, USA
[3]McGill University, Department of Biology, H3G0B1, Montreal, Canada
[4]University of New South Wales, Evolution & Ecology Research Centre, 2052, Sydney, Australia

Background: Despite significant efforts, there are still major scientific uncertainties in our understanding of drought impacts upon tropical forests. Recent work has highlighted both the potential susceptibility of tropical forests to drought, and the need for improved modelling. We especially need to develop a better mechanistic understanding linking how observed functional trait syndromes lead to different tree responses to drought. In this context, it is reasonable to assume that biogeographic history and past ecological filters over evolutionary time, as well as current climatic differences may have sculpted continental differences in the functional trait space exploited by plants and thereby determine drought responses of tropical forests today.
Methods: We explored both the climatic and floristic distinctiveness of tropical forests across three broad continental regions (Americas, Africa, Australasia), and discuss the implications of these differences upon predicting pan-tropical drought responses.
Results: Across tropical forested (>70% tree cover) regions, African forests experience a higher cumulative water deficit and seasonality of rainfall as compared to similar Australasian forests, which enjoy a more equitable maritime climate; forests in the Americas are intermediate. Parallel to this finding Africa and Australasian forests are found to be the most dissimilar floristically driven by unique clades distinctive of both. These floristic differences, a result of differences in past and current ecological filters and continental biogeography, likely indicate variation in the functional trait space occupied by forests across continents. Despite the current paucity in trait data from several key tropical regions it is likely that the observed difference in floristics and presumably trait-space foreshadows continental differences in tropical forest responses to future drought.

O29-02 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

The relative evolutionary rarity of drought adaptation revealed by community phylogenetic analyses across lowland tropical South America

KYLE DEXTER[1], DANILO NEVES[2], TIM BAKER[3], FERNANDA COELHO[3], TOBY PENNINGTON[4], ARY OLIVEIRA-FILHO[5]
[1]University of Edinburgh, School of GeoSciences, EH93FF, Edinburgh, United Kingdom
[2]Royal Botanic Garden Kew, Tropical Americas Team, TW93AB, Richmond, United Kingdom
[3]University of Leeds, School of Geography, LS29JT, Leeds, United Kingdom
[4]Royal Botanic Garden Edinburgh, Tropical Diversity, EH35LR, Edinburgh, United Kingdom
[5]Universidade Federal de Minas Gerais, Departamento de Biologia, 31270-910, Belo Horizonte, Brazil

Background: Several recent studies have shown how phylogenetic niche conservatism for non-frosted environments shapes global patterns of plant biodiversity. Namely, the inability of most plant lineages to survive regular frost is a major force underlying the latitudinal diversity gradient. However, there is another major axis of plant stress, drought, for which the role of phylogenetic niche conservatism in shaping global patterns has yet to be assessed.
Methods: In order to provide a case study on this topic, we focus on lowland tropical South America, using a database of ~2000 tree inventories distributed from wet Amazon rain forest to arid Caatinga woodlands. We combine this with a phylogeny for >1100 angiosperm plant genera.
Results: We find that not only does species richness decline as one moves from wet to dry along precipitation gradients, but that lineage diversity, measured as the deviation from expected phylogenetic diversity given species richness, also decline. In other words, dry areas not only have few species, but those species are unevenly distributed across angiosperm phylogeny, being concentrated in a few clades.
Discussion: Our results demonstrate that phylogenetic niche conservatism for wet as well as warm environments plays a major role in shaping global patterns of plant biodiversity. This finding suggests that the ancestral angiosperm may have been found in tropical rain forest.

O29-03 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Amazon forest response to the 2010 drought

TED FELDPAUSCH[1], OLIVER PHILLIPS[2], ROEL BRIENEN[2], EMANUEL GLOOR[2], JON LLOYD[3], GABRIELA LOPEZ-GONZALEZ[2], ABEL MONTEAGUDO-MENDOZA[4], RAINFOR[5]
[1]University of Exeter, Geography, College of Life and Environmental Sciences, EX4 4RJ, Exeter, United Kingdom
[2]University of Leeds, School of Geography, LS2 9JT, Leeds, United Kingdom
[3]Department of Life Sciences, Imperial College London, SL5 7PY, Ascot, United Kingdom
[4]Universidad Nacional San Antonio Abad del Cusco, Cusco, Peru
[5]RAINFOR, Amazon Forest Inventory Network

The Amazon Basin has experienced more variable climate over the last decade, with a severe and widespread drought in 2005 causing large basin-wide losses of biomass. A drought of similar climatological magnitude occurred again in 2010; however, there has been no basin-wide, ground-based evaluation of effects on vegetation. We address the question to what extent the 2010 drought affected forest dynamics using ground-based observations of mortality and growth utilizing data from a basin-wide forest plot network. We examine the impact of the 2010 drought on Amazon forest dynamics with the aim of quantifying a ground-based estimate of the impact of the event on growth and mortality in intact forests and estimating the basin-wide biomass carbon impact.

O29-04 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Drought-related resilience and tipping points in tropical rainforests

MARINA HIROTA[1,2], RAFAEL SILVA OLIVEIRA[2]
[1]Federal University of Santa Catarina, Department of Physics, 88040-900, Florianopolis, Brazil
[2]University of Campinas, Department of Plant Biology, 13083-862, Campinas, Brazil

Terrestrial ecosystems have been undergoing unprecedented climate and human-induced disturbances, which are likely to push these systems towards changes in their structure and functioning. It has been hypothesized that these new configurations may be alternative regimes of systems comprising vegetation-climate-disturbance interactions. Thus, one way of explaining the dynamics of ecosystems in transition may be the theory of multi-stability (TMS) and concepts such as resilience, hysteresis and tipping points. However, whether such multiple regimes indeed exist in climate-vegetation-disturbance systems and whether we can identify and quantify tipping points of such systems still remain largely unclear due to various reasons such as the role of heterogeneity and multi-scale processes in amplifying or dampening hysteresis and environmental change. We aim at presenting and discussing a conceptual framework to infer resilience of tropical rainforests, based on a reconciled view among the theory of multi-stability and the vast ecological literature about the response of these forests to various types of disturbances. Additionally, we highlight the complexity added to the system when different temporal and spatial scales are considered, and discuss the main drawbacks of this framework.

O29-05 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Modelling of drought-induced tree mortality in a Bornean tropical rainforest

TOMO'OMI KUMAGAI
Nagoya University, Institute for Space-Earth Environmental Research, 464-8601, Nagoya, Japan

Drought-related tree mortality at a regional scale causes drastic shifts in carbon and water cycling in Southeast Asian tropical rainforests, where severe droughts are projected to occur more frequently, especially under El Niño conditions. To provide a useful tool for projecting the tropical rainforest dynamics under climate change conditions, we developed the Spatially Explicit Individual-Based (SEIB) Dynamic Global Vegetation Model (DGVM) applicable to simulating mechanistic tree mortality induced by the climatic impacts via individual-tree-scale ecophysiology. In this study, model results were compared with observations collected at a field site in a Bornean tropical rainforest, and after validating the model's performance, numerical experiments addressing a future of the tropical rainforest were conducted using some global climate model (GCM) simulation outputs.

O29-06 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

The Daintree Drought Experiment

SUSAN LAURANCE, YOKO ISHIDA, DAVID TNG, DEBORAH APGAUA, SCOTT PARSONS
James Cook University, College of Marine and Environmental Sciences, 4870, Cairns, Australia

Background: Future climate projections suggest that droughts, which already affect large expanses of tropical rainforest globally, could become more frequent and intense in the future. Elevated tree mortality is one of the most important responses to severe drought and may provoke changes in forest structure, species composition, and flammability, but the precise cause of tree death is poorly understood.
Method: In May 2015, we installed an in-situ drought experiment in wet lowland rainforest in north-eastern Australia. The experiment explores plant-water use from soil pits 1.5 m deep, up through 60 tree stems, with sap flow and logging dendrometers, to the canopy accessed by a 47 m-tall canopy crane. Our plant trait research focused on assessing drought vulnerability in 90 species from 6 different life-forms, whereas ecology studies explored demographic patterns and trophic interactions such as herbivory and disease in drought-stressed plants.
Results: We observed significant differences in hydraulic traits and function between life forms and within canopy species. For example, we found that woody lianas had large xylem vessels ensuring hydraulic efficiency and rapid growth. In contrast, understorey-trees and -shrubs exhibited greater safety with numerous narrow vessels and high wood densities. Our 8 canopy species (with sap flow units) are ecologically dominant comprising <10% of tree species richness but > 40% of stand biomass. Pre-drought data show the canopy palm has the highest max. sap flow rates (up to 2-3 x greater than other trees) and significant seasonal patterns in water use. Daily water consumption in trees was highly variable within and between species, with tree size the best overall predictor of high transpiration rates. Three tree species, in particular, warrant further study for they support ¼ of total stand biomass and contribute significantly to the stand transpiration with sapflow volumes 2-4 times higher than the other studied species. Finally, drought research is dominated by plant physiology studies greatly ignoring top-down ecosystem processes. Our preliminary research into these trophic processes has found significantly elevated levels of disease and mealy bugs in the foliage of drought-stressed plants.
Conclusions: In-situ experiments are not perfect, but their advantage is that they provide a whole ecosystem perspective and reinforce the need for multi-disciplinary approaches to climate change research.

O29-07 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

The effects of drought on respiration in tropical rainforest

PATRICK MEIR[1], LUCY ROWLAND[2], ANTONIO CL DA COSTA[3], MAURIZIO MENCUCCINI[4], RAFAEL OLIVEIRA[5], OLIVER BINKS[6], STEEL VASCONCELOS[7], ALEX DE OLIVEIRA[3], YANN SALMON[6], LEANDRO FERREIRA[9], PATRICK MEIR[6]
[1]Australian National University, Research School of Biology, 2601, Canberra, Australia
[2]Exeter University, Geography, EX1, Exeter, UK
[3]Universidade Federal de Para, Geociencias, PA 555-10, Belem, Brazil
[4]ICREA, CREAF, BA2, Barcelona, Spain
[5]Universidade de Campinas, Inst. de Biologia, SP234, Sao Paulo, Brazil
[6]University of Edinburgh, School of Geosciences, EH93FF, Edinburgh, UK
[7]EMBRAPA, Ecologia, PA555-07, Belem, Brazil
[8]Museu Goeldi, Botanica, PA121-1, Belem, Brazil

The likelihood of future drought and warming threatens the functioning and stability of tropical rainforests, which themselves are responsible for a large fraction of global terrestrial productivity and land-atmosphere energy exchange. Understanding the response by trees to drought is central to our attempts to predicting its long term effects on tropical forests, and also to understanding why the tropics appear to dominate the large observed El Nino-related inter-annual variability signal in the annual rise in atmospheric concentration of carbon dioxide. Process-level insight into these globally important flux responses and flux anomalies is needed to advance fundamental understanding of the Earth system, and to improve the reliability of model-based predictions of tropical forest ecosystem properties. Process-based insight is best obtained by combining observation with manipulative experimentation. Recent results from the world's only long-running ecosystem-scale rainfall exclusion experiment in tropical rainforest have led to a focus on hydraulic vulnerability of branch xylem and gas exchange capacity in the canopy in relation to mortality risk and productivity. Here we examine the role of autotrophic respiration, reporting significantly increased rates of respiration under long term drought. How does respiration respond to soil moisture deficit over long and short time periods? What are the carbon sources of respiration during drought? Can temperature sensitivity explain El Nino impacts on land-atmosphere interactions with respect to CO_2 emissions from tropical forest? We use direct and derived measurements of respiration from plant tissue to address these questions and integrate them with the preceding related questions concerning drought effects on mortality and productivity.

O29-08 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

The diversity of drought tolerance, as predicted by leaf water potential at turgor loss point, within an Amazonian forest.

ISABELLE MARÉCHAUX[1], MEGAN K. BARTLETT[2], LAWREN SACK[2], JÉRÔME CHAVE[1]
[1]CNRS/Université Paul Sabatier/ENFA, Laboratoire Evolution et Diversité Biologique UMR5174, F-31062, Toulouse cedex 9, France
[2]University of California Los Angeles, Department of Ecology and Evolution, 90095, Los Angeles, California, USA

Background: Amazonian forest communities have already been seriously impacted by extreme natural droughts, and intense droughts are predicted to increase in frequency. However, our knowledge of Amazonian plant species' responses to water stress remains limited, as current plant trait databases include few drought tolerance traits, impeding the application and predictive power of models.
Methods: We estimated leaf water potential at wilting or turgor loss point (TLP), a determinant of leaf drought tolerance, using a recent method based on the measurement of leaf osmotic water potential at full hydration. This method was applied for 165 trees (of 71 species) and 15 lianas in a forest in French Guiana during the dry season. We repeated this sampling during a wet season on 79 trees, 39 tree saplings, 16 understory plants and 43 lianas (of respectively 10, 5 and 3 species and more than 10 families). We also measured other commonly measured functional traits, such as leaf mass per area, nutrient content and carbon isotopic ratio, on the same leaves. We explored (i) the diversity of TLP values across plant types and species, (ii) intra-specific variability across tree size and season and (iii) the relationships between TLP and other traits.
Results: We found that TLP varied widely across tree species, with early-successional species having less drought-tolerant leaves than late-successional ones. Species identity was the major driver of TLP variation in trees, whereas season, canopy tree size and leaf exposure explained little variation. Lianas had less drought tolerant leaves than trees during the wet season but not during the dry season, owing to a stronger seasonal adjustment in liana leaves. Values of TLP across species and plant types were weakly or not correlated with other commonly measured plant functional traits.
Discussion: The broad spectrum in TLP suggests a potential for diverse responses to drought within tropical forest communities, both among species and plant types. Vegetation models seeking to predict forest response to drought should integrate improved quantification of drought tolerance traits among plant species. We discuss the integration of our findings within an individual-based and mechanistic model of tropical forest dynamics.

O29-09 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Predicting drought susceptibility using hydraulic traits in the Amazon

RAFAEL OLIVEIRA, MAURO MONTEIRO BRUM JR
University of Campinas, Plant Biology, 13083-970, Campinas, Brazil

Background: Predictions of drought-related tree mortality in Amazonian forests require information about key hydraulic traits of dominant tree species.
Method: To evaluate the diversity of drought tolerance in a Central Amazonian forest, we investigated the vulnerability of the transport system to drought-induced embolism, wood density (WD), the minimal seasonal water potential (Ѱmin) and the hydraulic safety marging for dominant tree species at the Tapajós National Forest, Pará, Brazil.
Results: We found substantial interspecific variation in the water potential at 50% loss of maximum hydraulic conductivity (P50). Large trees in the overstory tended to be less resistant to drought-induced embolism than small understory trees, a result consistent with the observations of higher mortality of larger trees in long-term drought exclusion experiments in the Amazon.
Conclusion: Most of the species operate at a very narrow safety margin (< 0.5 MPa), indicating that they operate very close to the point of xylem hydraulic failure and therefore are very susceptible to drought-induced mortality.

O29-10 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Traits, drought tolerance and the distribution of tropical tree species

LOURENS POORTER
Wageningen University, Forest Ecology and Forest Management Group, 6700 AA, Wageningen, The Netherlands

Background: Rainfall and plant water availability are the main drivers of large-scale gradients in species distribution, composition, and richness in lowland tropical forests. Here I evaluate the underlying mechanisms shaping the drought tolerance and distribution of Amazonian and West African tree species.
Method: Species were screened for their morphological, physiological and hydraulic traits and for their drought survival. Trait-based plant responses to water and light gradients were modelled using a physiological model, and linked to species distribution along small-scale topographic and large scale climatic gradients in water availability, using plot data.
Result: A comparative dry-down experiment indicates that the ability of tropical tree species to survive prolonged periods of drought is related to drought avoidance (deciduous leaf habit), and water storage in the taproot. For evergreen species drought survival is positively related to wood density and cavitation resistance. Using an ecophysiological model, it is shown that species' functional traits shape the whole-plant water compensation point. Species variation in water compensation point allows for local coexistence in a tropical dry forest, and predicts species distribution across large-scale gradients in water availability.
Conclusions: Morphological and hydraulic traits underlay the drought tolerance and distribution of tree species. Future climate change and increased drought may therefore have local effects on species coexistence, and regional effects on species distribution.

O29-11 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Is sap flow a good indicator of drought-induced mortality risk in tropical rainforest.

LUCY ROWLAND[1], ANTONIO DA COSTA[2], RAFAEL OLIVEIRA[3], OLIVER BINKS[4], STEPHEN SITCH[5], STEEL VASCONCELOS[6], ALEX OLIVEIRA[7], YANN SALMON[8], LEANDRO FERREIRA[9], MAURIZIO MENCUCCINI[10], PATRICK MEIR[10]
[1]University of Exeter, Geography, EX4 4RJ, Exeter, UK
[2]UFPA, Geosciences, 66075-110, Belem, Brazil
[3]UNICAMP, Instituto de Biologia, 13083-862, Campinas, Brazil
[4]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK
[5]University of Exeter, Geography, EX4 4RJ, Exeter, UK
[6]EMBRAPA, Amazônia Oriental, 66095-903, Belem, Brazil
[7]Museu Paraense Emilio Goeldi, Ecologia, 66040-170, Belem, Brazil
[8]University of Helsinki, Department of Forest Science, PL 27, Helsinki, Finland
[9]Museu Paraense Emilio Goeldi, Ecologia, 66040-170, Belem, Brazil
[10]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK

In the coming century increased drought intensity and frequency is likely to be a key driver of increasing tree mortality rates within tropical rainforest. However drought-induced mortality risk within a diverse tropical rainforest setting is complex and remains poorly understood. Our recent results, from a tropical rainforest through-fall exclusion experiment (TFE) in Amazonia showed hydraulic vulnerability to be greatest in the largest trees and in taxa which are more sensitive to drought. Here we expand upon existing findings from the TFE using sap-flow data for replicate trees from sensitive and resistant taxa and a corresponding control plot. Sap-flow data were collected continuously throughout 2015, on tree taxa known to be sensitive and resistant to drought, enabling the response to a strong El Niño event to be captured alongside the experimental drought. Our results suggest that trees on the TFE experience far greater seasonal declines in sap-flow during the El Niño, than corresponding trees from the non-droughted control plot. Hourly sap flow is strongly correlated with vapour pressure deficit and radiation on both plots, however seasonal changes in diurnal sap-flow patterns differ considerably between the TFE and control and between the tree taxa which are sensitive and resistant to drought. Our data demonstrate that trees which are already suffering from existing low soil water potentials suffer far greater restrictions in sap flow and whole tree productivity during intense dry seasons, such as that implemented by the 2015 El Niño event. These data support and extends our previous findings, that hydraulic vulnerability is likely to be the key factor determining drought-induced mortality risk.

O29-12 – S29 *Impacts of drought on tropical forests: processes and tipping points*
Tuesday 21 June / 10:00-15:30 – Barthez

Large-scale modelling of the impact of drought on the land carbon cycle

STEPHEN SITCH[1], GUILLERMO MURRAY-TORTAROLO[1], CHRIS HUNTINGFORD[2], BEN BOOTH[3], MARTIN JUNG[4], LUCY ROWLAND[1], PIERRE FRIEDLINGSTEIN[1], PATRICK MEIR[5], MAURIZIO MENCUCCINI[6], PETER COX[1], LINA MERCADO[1], TRENDY CONSORTIUM
[1]University of Exeter, EX6 8RN, Exeter, UK
[2]Centre for Ecology and Hydrology, Wallingford, Wallingford, UK
[3]Met Office Hadley Centre, Exeter, UK
[4]Max Planck Biogeochemistry, Jena, DE
[5]Australian National University, Canberra, AUS
[6]CREAF, Barcelona, ESP

We present model-based findings on the role of tropical ecosystems in the control of atmospheric CO2 growth rate in response to ENSO climate variability (Jung et al., 2016), and the impact of the changes in the dry season on terrestrial productivity over the recent past (Murray-Tortarolo et al., 2016). Furthermore using global models we investigate the resilience of tropical rainforests to future climate change (Booth et al., 2012; Huntingford et al., 2013). Finally, we present new approaches to model drought response suitable for inclusion in global models.
Each year a consortium of Dynamic Global Vegetation Modelling groups (TRENDY) perform a factorial set of global simulations over the historical period, 1901 – present, to investigate the temporal and spatial trends in the land sink, and to attribute to environmental drivers. Typically around 10 models are forced with reconstructed observed climate, global atmospheric CO2, gridded fields of historical land-use and land cover changes (LULCC), and nitrogen deposition. Results from the TRENDY project (Sitch et al., 2015) will be presented, in particular, how changes in dry season intensity is a key driver of regional net primary production trends (Murray-Tortarolo et al., 2016). Using the TRENDY process-based ensemble and eddy-covariance data-derived empirical models we show how moisture balances cause temperature to dominate land carbon sink interannual variability (Jung et al., 2016).
We show how a large uncertainty in future climate prediction is associated with land carbon cycle processes and their representation in global models (Booth et al., 2012). In addition, we present results from the JULES land surface scheme driven with climate patterns from 22 climate models to investigate the future resilience of tropical rainforest to climate change. Finally, we present some new ideas on how to represent plant response drought in global models with ecosystem demography.

O30-01 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

A conceptual framework for experimental manipulations in tropical rainforests

EGGLETON PAUL
Natural History Museum, Life Sciences, SW7 5BD, London, UK

Ecological experiments are common in temperate regions but rare in the tropics. In this talk I will explore the difficulties of applying the experimental and statistical methods devised for (and applied to) experiments in simple temperate systems (e.g. wheat fields) to tropical systems. These conventions include: replication (and pseudoreplication), standardisation, differences in diversity and manipulation constraints. How far can classical statistical methods be stretched to fit tropical examples? I provide some examples of tropical experiments and how they were conducted and analysed and make some tentative general suggestions as to how such experiments should be structured.

O30-02 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

Exploring the functional importance of ants in tropical rain forests

HANNAH GRIFFITHS[1], LOUISE ASHTON[2], PAUL EGGLETON[3], THEODORE EVANS[4], CATHERINE PARR[5]
[1]The University of Liverpool, School of Environmental Sciences, L69 3GP, Liverpool, United Kingdom
[2]The Natural History Museum, Entomology, SW7 5BD, London, United Kingdom
[3]The Natural History Museum, Entomology, SW7 5BD, London, United Kingdom
[4]University of Western Austrailia, School of Animal Biology, WA 6009, Perth, Austrailia
[5]The University of Liverpool, School of Environmental Sciences, L69 3GP, Liverpool, United Kingdom

Given the rapid rate of global biodiversity loss caused by habitat change and degradation, it is essential to understand the implications of species declines and local extinctions for ecosystem processes. While there is growing evidence that biodiversity is positively associated with the functioning of ecosystems, surprisingly, there has been very limited quantification of the contribution different taxa make to ecosystem processes in natural systems at large-scales. In tropical forests, which are experiencing globally the highest rates of habitat conversion and species losses, ants (Hymenoptera: Formicidae) are the dominant terrestrial invertebrate group, making up around 75% of all individuals. Their functional value was highlighted by E.O. Wilson (1987) who famously declared invertebrates are the "little things that run the world". However, while it is generally accepted that ants fulfil important functions, few studies have tested these assumptions at large scales and demonstrated the ecological consequences of their absence. Here I report on findings from a novel large-scale field experiment in an undisturbed tropical rainforest in Malaysian Borneo, where we suppressed the abundance of ants. I report on the influence of ants on two key ecosystem processes: the top-down control of herbivorous invertebrates and resultant implications for seedling herbivory and survivorship as well as soil nutrient cycling.

O30-03 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

The Borneo rainforest girdling experiment: responses in ecophysiology and soil processes

TERHI RIUTTA[1], ALEXANDER CHEESMAN[2], ANDREW NOTTINGHAM[3], CHRISTOPHER DOUGHTY1, MING NIE[4,5,] ELIZABETH TELFORD[5], WALTER HUARACA HUASCO[6], MUHAMMAD FIRDAUS ABDUL KARIM[5], ALEXANDER SHENKIN[1], CHARLES S VAIRAPPAN[7], NOREEN MAJALAP[8], PATRICK MEIR[3,9], YIT ARN TEH5, YADVINDER MALHI[1]
[1]Institution : University of Oxford - Department : School of Geography and the Environment, Environmental Change Institute, OX1 3QY Oxford - UK
[2]Institution : James Cook University - Department : College of Marine and Environmental Sciences, QLD 4870 Cairns - Australia
[3]Institution : University of Edinburgh - Department : School of Geosciences, EH9 3FF Edinburgh - UK
[4]Institution : Fudan University - Department : School of Life Sciences, 200438 Shanghai - China
[5]Institution : University of Aberdeen - Department : Institute of Biological & Environmental Sciences, AB24 SFX Aberdeen - UK
[6]Institution : Universidad Nacional San Antonio de Abad - Department : Herbario Vargas, 0.48 Cusco - Peru
[7]Institution : Universiti Malaysia Sabah - Department : Institute for Tropical Biology and Conservation, 88450 Kota Kinabalu - Malaysia
[8]Institution : Forest Research Centre - Department : Sabah Forestry Department, 90715 Sandakan - Malaysia
[9]Institution : Australian National University - Department : Research School of Biology, ACT 2601 Canberra - Australia

Forest ecosystem carbon balance is regulated mainly by the two largest fluxes: photosynthesis and ecosystem respiration. Photosynthesis products (photosynthates) are transported in phloem tissue and allocated to autotrophic respiration, biomass production, storage as non-structural carbohydrates, and root exudates. Belowground, photosynthates are used for root growth and metabolism, mycorrhizal metabolism, nutrient uptake, and substrate for microbes, which in turn affect soil respiration and other trace gas fluxes. The contribution of photosynthates to tree carbon and water budgets and to the belowground processes can be studied by experimentally modifying the sugar transport. Girdling is a treatment in which a strip of bark (including cambium and phloem, but leaving the xylem intact) is removed from around the tree trunk. This stops the transport of sugars below the girdle, and diminishes the supply of this labile carbon into the soil. To our best knowledge, this is the first ecophysiology-focused girdling study at a large spatial scale in a mixed-species tropical forest.
The study site is in a selectively logged tropical forest in Sabah, Malaysian Borneo, within the Stability of Altered Forest Ecosystem (SAFE) Project. The site is located in a concession that will be converted to oil palm, which created an opportunity to conduct a large-scale disruptive experiment. The site is a permanent 1-ha plot with four years of previous data on carbon dynamics available. Half of the plot was girdled in February 2016, while the other half was left as control (Before-After; Control-Impact Design). We are monitoring the response of individual trees (sap flow, growth, non-structural carbohydrate stores, photosynthesis, respiration) and soil ecosystem (total and partitioned respiration, nitrogen cycle, fine root dynamics, microbial community).
We will describe the response of major components of the plant carbon and water cycle for several months after the girdling event. During the first four weeks post-girdling, there was a pronounced decrease in stem respiration below the girdle, indicating the importance of recent photosynthates and sugar transport in stem respiration and the success of the girdling treatment. Soil respiration showed a subtle decrease, due to the decrease in root and rhizosphere respiration.
Such experiments increase our quantitative understanding of tropical forest ecosystem functioning and the linkages of above and belowground processes.

O30-04 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

Indicator taxa revisited: Tropical forest disturbance causes consistent responses in species composition but not species richness

Nigel Stork[1], Diane Srivastava[2], Paul Eggleton[3], Mike Hodda[4], Roger Leakey[5], Allan Watt[5]
[1]Griffith University, Environmental Futures Research Institute, Griffith School of Environment, 4111, Brisbane, Australia(
[2]University of British Columbia, Dept of Zoology & Biodiversity Research Centre, Vancouver, Canada
[3]The Natural History Museum, Life Sciences Department, London, UK
[4]CSIRO, Ecosystem Sciences, Canberra, Australia
[5]Centre for Ecology and Hydrology, Edinburgh, UK

Background: Conservation efforts focused on single groups of organisms often assume that the responses of the focal group can serve as an indicator or surrogate for the responses other groups to perturbations. One of the most highly cited rebuttals of the indicator taxa concept was a study on how the species richness of eight animal groups responded to anthropogenic forest disturbance in Cameroon (Lawton et al. 1998. Biodiversity inventories,indicator taxa and effects of habitat modification in tropical forest. Nature 391: 72-76). However, an emerging paradigm in conservation biology is that species composition is much more informative of conservation value than is species richness, at least at the local level. Further, impacts of disturbance can affect functional diversity and through that, ecosystem processes.
Methods: We reanalyze six animal groups (canopy ants, ground ants, termites, canopy beetles, nematodes, butterflies) of the original eight taxon Cameroonian dataset in terms of species composition as well as species richness, using a more comprehensive and multivariate measure of forest disturbance based on years since disturbance, current tree cover, soil compaction and tree removal.
Results and Discussion: Our analysis demonstrates that effects of disturbance on species composition are always much stronger than effects on species richness and are mostly concordant between taxa. As some others have found, species richness for most groups did not decline with disturbance level. Instead observed change in species composition was largely due to turnover with disturbance intolerant species being replaced by more disturbance tolerant species. Although disturbance generally caused changes in composition, the strength of this relationship depended on the disturbance driver and the functional group considered.
Conclusions: This re-analysis suggests that the indicator taxa concept may be more useful than previously thought.

O30-05 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

Changes in bioturbation related to logging of rain forest and conversion to oil palm plantation in Borneo

TUMA JIRÍ

Background: Bioturbation is the process of relocation and structural alteration of soil and mixing of soil particles via the activity of plants and animals. Because bioturbation impacts the soil environment and subsequently the whole ecosystem, it can be described as an ecosystem engineering process. Despite the importance of this process, it is not known how it changes in relation to habitat degradation. Understanding these changes is particularly important in the tropics, where logging of primary forest and conversion to agriculture (increasingly to oil palm plantation) represents a typical cascade of human-caused changes.
Methods: In this study we measured the visible aboveground animal-driven bioturbation in three different habitats (old growth forest, logged forest and oil palm plantation) in Sabah – Borneo. In each habitat, the animals generating all the aboveground soil structures from six 625 m2 plots were identified, and the structure themselves were collected, oven-dried and weighted.
Results: The most important groups of bioturbating organisms across all three habitats were termites (91.9%), followed by cicadas (3.8%), other unidentified burrowers (2%), earthworms (1.8%), and ants (0.6%). Overall bioturbation was highest in oil palm plantation, followed by logged forest with old growth forest having the lowest rates. However, 99.9 % of the bioturbation in plantations rely on only one species of termite (Macrotermes gilvus).
Discussion: Bioturbation in oil palm plantation is dependent on a single agent, and hence is vulnerable to species extinctions. The opposite pattern in bioturbation values is observed when the data of M. gilvus are excluded from the dataset, as M. gilvus builds only large, heavy nests, typically found once per 625 m2 plot, while logged forest and old growth forest also host other groups of bioturbators. Bioturbation in logged forests seems to be compensated by other soil fauna and by the presence of Dicuspiditermes nemorosus and Dicuspiditermes santschii termites, which are abundant in old growth forest, but do not survive in oil palm plantation. Taken together, these findings underline the fact that termites play an important role in soil mixing in the tropics, and suggest that bioturbation in oil palm plantations is highly vulnerable to the extinction of the termite M. gilvus.

O30-06 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
Tuesday 21 June / 16:00-17:30 – Barthez

Tropical responses to altered climate experiment: Initial results from a field warming experiment in Puerto Rico

TANA WOOD[1], SASHA REED[2], MOLLY CAVALERI[3]
[1]USDA Forest Service, International Institute of Tropical Forestry, 00926, San Juan, USA
[2]U.S. Geological Survey, Southwest Biological Science Center, 84532, Moab, USA
[3]Michigan Technological University, School of Forest Resources & Environmental Science, 49931, Houghton, USA

Tropical forests play a major role in regulating global carbon fluxes and stocks. Therefore, even small changes to carbon cycling in these productive ecosystems could dramatically affect atmospheric carbon dioxide concentrations and thus global climate. Temperature is expected to increase significantly in tropical regions within the next two decades, yet we have a surprisingly poor understanding of how tropical forests will respond to this significant climatic change. While natural temperature gradients in the tropics offer great opportunities for understanding temperature effects on plant and ecosystem functioning, predicted temperature regimes are not present in the lowland tropics today. Thus, the only way to achieve predicted temperature regimes for these systems is to manipulatively warm the warmest forests. Here we present a novel field warming experiment recently established in Puerto Rico to address this question: Tropical Responses to Altered Climate (TRACE). The primary goal of this experiment is to investigate effects of increased temperature on key biological processes that control tropical forest carbon cycling and to establish what steps should to be taken to resolve the uncertainties surrounding tropical forest responses to increasing temperatures. We will describe the experimental design, including the wide range of measurements being conducted. We will additionally present results from the initial phase of warming. By utilizing the mechanism-based approach presented here, we aim to improve Earth System Model parameterization of the pools and fluxes of carbon and nutrients in tropical forested ecosystems.

O31-01 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Climatic niche evolution in tropical plants: an Andes-Amazon phylogenomics perspective

CHRISTOPHER DICK[1], JAMES PEASE[1], STEPHEN SMITH[1], MILES SILMAN[2], WILLIAM FARFAN-RIOS[2]
[1]University of Michigan, Ecology and Evolutionary Biology, 48109, Ann Arbor, USA
[2]Wake Forest University, Biology, 27106, Winston-Salem, USA

The study of range limits and climate change impacts in tropical plants is in its infancy and has been largely devoid of mechanistic underpinning. To address this gap, we are applying tools of phylogenomics to understand within and among-species patterns of climatic niche evolution of plants within an elevational, climatic, and floristic structure gradient in southern Peru. The ABERG floristic transect extends 3500 m in elevation from lowland Amazon rain forest to the tree line of the Andes. The overarching question is: What genetic factors contribute to climatic niche evolution in tropical plants? Within this broad topic, we have three narrower objectives: (1) Identify genetic loci that contribute to cold and heat shock tolerance in a suite of neotropical plant genera; (2) Compare transcriptome-wide patterns of gene expression associated with climatic niches; and (3) Infer the (phylogenetic) macroevolution of climatic niches and their biogeographic assembly in the study taxa.

O31-02 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Understanding the history of African shade-tolerant and pioneer rainforest trees, applying new genomic tools to phylogeography

JÉRÉMY MIGLIORE[1], ESRA KAYMAK[1], CÉDRIC MARIAC[2], THOMAS L. P. COUVREUR[2], BRANDET-JUNIOR LISSAMBOU[3], YVES VIGOUROUX[2], OLIVIER J. HARDY[1]
[1]Université Libre de Bruxelles (ULB), Evolutionary Biology and Ecology (EBE), 1050, Bruxelles, Belgium
[2]Institut de Recherche pour le Développement (IRD), Diversité - Adaptation - Développement (DIADE), 34394, Montpellier, France
[3]Université des Sciences et Techniques de Masuku (USTM), Laboratoire de Pathologie et Toxicologie végétales (LBPV), Franceville, Gabon

Background: Palaeoecological research revealed that the equatorial African rainforest has undergone drastic floristic, structural and phytogeographical changes during the Quaternary period. Drawing up the geographical distribution of genetic lineages of rainforest trees and their filiations through the development of phylogeography appears as a key complementary approach to better understand the response of biodiversity to past climate oscillations. Especially, the development of next generation sequencing (NGS) and bioinformatic tools support new genomic challenges to reconstruct whole genomes, and therefore to infer the temporal dynamics of forest vegetation, including species belonging to distinct functional groups.
Methods: The capture and sequencing of chloroplast genomes at deep multiplexing levels have been undertaken using NGS on 140 individuals of the rainforest long-living and shade-tolerant tree Greenwayodendron suaveolens (Annonaceae), which is characteristic of Central African mature forests. In parallel, 80 individuals of the emblematic pioneer and short-living tree Musanga cecropioides (Urticaceae) have been also analyzed. Bioinformatic tools were used for the calling of single nucleotide polymorphism (SNP) and application of phylogenetic and molecular dating reconstructions.
Results: The polymorphism found on almost whole chloroplast genomes ranged between 224 SNPs along c. 120 kb for M. cecropioides to 2,871 and even 7,360 SNPs along c. 130 kb for G. suaveolens without and with outgroup taxa respectively. These high levels of polymorphism for Greenwayodendron could suggest cryptic taxa, involving a taxonomic revision. In any case, this high amount of DNA sequences provides a very detailed phylogeographical signal to infer the evolutionary history of populations, while previous single marker sequencing suffered limited polymorphism.
Discussion: Both forest populations of Greenwayodendron and Musanga are characterized by distinct cpDNA phylogroups, mainly in Upper Guinea and in northern, eastern and western parts of the Lower Guinean and Congolian forests. Populations could have been fragmented into a restricted number of refugial areas in the past that seems display diverse demographic signatures. But ongoing molecular dating should provide a more precise temporal framework for comparing the diversification of each phylogroups, and the role of their life history traits in terms of resilience during glacial/interglacial oscillations.

O31-03 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Evolutionary history in a polyploid complex of African tropical trees: reconstruction of phylogeny, phylogeography and historical changes in the Afzelia genus (Fabaceae-Caesalpinioideae)

ARMEL S.L. DONKPEGAN[1], JEAN-LOUIS DOUCET[1], KASSO DAINOU[2], JÉRÔME DUMINIL[3], OLIVIER J. HARDY[4]
[1]Gembloux Agro-Bio Tech/University of Liege, Biosystem engineering/Tropical Forestry, 5030, Gembloux, Belgium
[2]Gembloux Agro-Bio Tech/University of Liege, Nature+ asbl / Tropical Forestry, 5030, Gembloux, Belgium
[3]CIFOR Central Africa Regional Office, Bioversity International, P.O. Box 2008, Yaounde, Cameroon
[4]Université Libre de Bruxelles, Evolutionary Biology and Ecology, 1050, Brussels, Belgium

Background: The fate of African tropical forests is a major concern for conservation, while their biodiversity is still poorly known. Molecular markers can improve our knowledge of their biodiversity, especially to decipher species evolution and delimitation within genera. While taxonomic relationships within Afzelia genus has been revised multiple times on the basis of phenotypic characters, evolutionary relationships among taxa representing the entire geographic range of the genus have not been determined.
Method: We used nuclear and chloroplast DNA associated with partial plastome sequences data to infer phylogenetic relationships among the six broadly distributed species of the genus: A. africana and A. quanzensis (savannah species), A. bipindensis, A. bella, A. pachyloba and A. parviflora (forest species). Using microsatellite markers (SSR), we also applied a clustering analysis (STRUCTURE) to verify whether the current taxonomic species delimitation matches the biological species concept, especially in forest species.
Result and discussion: Our SSR data showed for the first time that savannah species are diploid while forest species are tetraploid. While nuclear DNA separates diploid and tetraploid species in two distinct clades, plastid markers show that one diploid species forms a well-supported clade with the tetraploids, suggesting historical hybridization, possibly in relation with genome duplication (polyploidization) and habitat shift from dry to rain forests. The genetic structure observed with SSR confirms the taxonomic delimitation of the two diploid species and one tetraploid species (A. pachyloba). It also suggests the existence of a single Afzelia forest species in West Africa, and the presence of two distint species within the A. bipindensis taxon, with potential hybridization with A. bella.
Conclusion: The evolutionary history of the genus Afzelia appears complex and the potential link between polyploidization and habitat shift is worth investigating further. Our data also show that species delimitation must be revisited, at least among three of the four rain forest species.

O31-04 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

History of the fragmention of the tropical African rain forest in the Dahomey Gap

BORIS B. DEMENOU[1], ROSALIA PINEIRO[2], OLIVIER J. HARDY[1]
[1]Université Libre de Bruxelles, Biologie des Organismes, B-1050, Bruxelles, Belgium
[2]Royal Botanic Gardens, Jodrell Laboratory, TW9 3DS, Kew, UK

Background: The Guineo-Congolian rain forest is composed of two main blocks, Upper Guinea (UG) and Lower Guinea (LG) + Congolia, separated by the «Dahomey Gap» (DG), a savanna corridor at the level of Benin and Togo. Palynological studies and reconstruction of paleo-environments show that the distribution of tropical African rain forest was affected by cyclical Quaternary climate changes.
Nowadays, relics of semi-deciduous forests which contain Guineo-Congolese species like the non-pioneer tree Distemonanthus benthamianus and pioneer Terminalia superba are still present within the DG. These two species might be used to study the history (timing) of the fragmentation of the rain forest in the DG and the impact of this fragmentation on infraspecific biodiversity.
Method: We genotyped 429 D. benthamianus and T. superba 247 individuals at, respectively, 11 and 14 nuclear microsatellites. We used Bayesian clustering analysis to infer gene pools within the entire distribution ranges of these species and compared their diversity and differentiation parameters. Indirect methods were used to infer gene dispersal distances. ABC analysis implemented in the software DIYABC v2.0 were then used to infer and date demographic changes within gene pool and to determine the origin of the DG populations.
Result and discussions: We obtained five gene pools in D. benthamianus (UG, DG and three related in LG) and four in T. superba (UG, DG and two in LG). Gene pool differentiation was higher in D. benthamianus (Fst between 0.18 and 0.29) than in T. superba (Fst between 0.04 and 0.09), a difference that might be explained by more limited seed dispersal in the former species. For both species, the DG gene pools were less diversified than the others gene pools. Demographic analysis showed that DG populations of D. benthamianus experienced a demographic decline at a timeframe consistent with the last glacial period (Last Glacial Maximum and the Holocene climatic Pejoration). However, for T. superba, analyses indicate rather a bottleneck around the penultimate glacial period. For both species, DG populations originated from admixture that occurred during the humid Holocene for D. benthamianus, but before around 40 ka B.P. for T. superba. This divergence might result from the difference in temperament of the species.
Conclusion: Our genetic study on both species allowed us to better understand the demographic events that occur within tropical African rain forest and their timing.

O31-05 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Hybridization and the evolution of tropical tree species complexes

MYRIAM HEUERTZ[1], SANNA OLSSON[2], PALOMA TORROBA-BALMORI[3]
STÉPHAN RAKOTONANDRASANA[4], ANDRIAMALALA RAKOTONDRAFARA[4], MELVIN BÉATRIX[1], HENRI CARON[5], CAROLINE SCOTTI-SAINTAGNE[6], STÉPHANIE MARIETTE[1], ALAIN FRANC[1], QUENTIN JEHANNE[1], ISABEL SANMARTÍN[2]
[1]INRA, Université de Bordeaux, UMR1202 BioGeCo, 33610, Cestas, France
[2]Real Jardín Botánico-CSIC, Plant Evolutionary Biology, 28014, Madrid, Spain
[3]INIA Forest Research Centre, Forest Ecology and Genetics, 28040, Madrid, Spain
[4]CNARP, Department of Ethnobotany and Botany, 101, Antananarivo, Madagascar
[5]INRA, UMR Ecologie des Forêts Guyanaises, 97310, Kourou, French Guiana
[6]INRA, UR0629 Écologie des Forêts Méditerranéennes, 84914, Avignon, France

Background: Tropical rainforest tree genera often comprise high numbers of species, and closely related species commonly occur in sympatry. There is little information on the proximal genetic mechanisms to explain these patterns of species coexistence. Theoretical models predict that inter-specific hybridization could represent a key factor in the maintenance of highly diverse communities, notably by retarding the (local) extinction of rare species and by allowing the sharing of beneficial genetic variants across species borders. Hybridization could be an especially relevant evolutionary process under climate change, where changes in relative species abundance, distribution ranges and/or phenology can affect interspecific gene flow, and where the sharing of adaptive genetic variation could allow a faster response to environmental change.
Methods: We set out to empirically test the importance of hybridization in closely related tree taxa, using as models the genus Symphonia (Clusiaceae) in Madagascar and the Bertholletia clade (Lecythidaceae) in French Guiana. We sampled sympatric populations of each complex and characterized samples at genetic markers (cpDNA, SSRs, SNPs or RAD-seq).
Results: Symphonia holds ca. 20 species endemic to Madagascar. However, taxonomic species boundaries are often poorly defined, and discriminant morphological characters for species delimitation are often unknown or unavailable on many herbarium vouchers. We thus applied genetic clustering approaches on "blind samples" (i.e., without using morphology) for taxon delimitation, we constructed a phylogenetic hypothesis and characterized patterns of admixture between taxa. In the Bertholletia clade, a pilot RAD-seq experiment allowed us to assess genomic patterns of allele sharing, a first step in characterizing the genomic dimension of introgression. In both complexes, plastid DNA sequences suggested evidence for plastid DNA sharing between several taxa.
Conclusion: Our ongoing work provides evidence for variable levels of allele sharing and genomic admixture between sympatric species in two tropical tree species complexes from different continents, suggesting that inter-specific hybridization took place in their evolution.

O31-06 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Comparative population genetics of tropical trees across a strong rainfall gradient: implications for species responses to climate change.

FRANK JONES
Oregon State University, Botany and Plant Pathology, 97331, Corvallis, USA

B Pronounced shifts in tropical dry season length and intensity are predicted as a result of climate change. Predicting how populations and communities will respond is a fundamental challenge for ecologists. Previous work has demonstrated large interspecific variation in co-occurring tropical tree species in their response to seasonal drought. However, we know less about intraspecific variation in drought responses and genetic diversity. How strongly individuals and populations vary in their drought responses, and the extent this variation is determined by genetic and environmental factors, will in part determine how populations,species, and tropical forest communities will respond to climate change. We present preliminary results from a project that is assessing intraspecific variation in drought responses for 16 species of tropical trees across a strong rainfall gradient in Central Panama (1700 - 3000 mm annual rainfall in ~ 70 km). The project combines reciprocal seedling transplants, common garden drought experiments, physiological measurements, and genetic analyses to assess the extent to which species show intraspecific variation in response to moisture and drought.In this symposium talk, we present preliminary results on howthose species examined to date vary in genetic diversity and differentiation across the rainfall gradient and the implications our results have for the movement of adaptive genetic variation. We choose 17 focal species that differ in their distribution across the rainfall gradient, with 5 species occurring across the entire gradient, 7 species are dry side restricted, and 5 species have predominantly wet side distributions. We found little genetic differentiation between populations in our focal species across small spatial scales using a genotype by sequencing approach. However, we do find significantly greater genetic diversity in all species examined at the wet end of the gradient. Reasons for concurrent patterns of high genetic diversity in wet vs. dry environments will be discussed.

O31-07 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Genome sequence and duplication of drought-responsive genes of a Southeast Asian dipterocarp, Shorea leprosula (Dipterocarpaceae)

KENTARO K. SHIMIZU[1], KEVIN KIT SIONG NG[2], MASAKI KOBAYAHI[3], JEFFREY FAWCETT[4], SOON LEONG LEE[2], ANG CHENG CHOON[1], MASAOMI HATAKEYAMA[1], TIMOTHY PAAPE[1], CHIN HONG NG[2], LEE HONG TNAH[2], CHAI TING LEE[2], JUN SESE[3], TOMOAKI NISHIYAMA[6], MAHARDIKA PUTRA[7], ISKANDAR Z SIREGAR[7], SAPTO INDRIOKO[8], AYAKO IZUNO[9], YUJI ISAGI[9]
[1]University of Zurich, Department of Evolutionary Biology and Environmental Studies and Institute of Plant Biology, 8057, Zürich, Switzerland
[2]Forest Reserach Institute Malaysia (FRIM), Genetics Laboratory, 52109, Kepong, Malaysia
[3]National Institute of Advanced Industrial Science and Technology (AIST), Biotechnology Research Institute for Drug Discovery, 135-0064, Tokyo, Japan
[4]The Graduate University for Advanced Studies, Sokendai, 240-0115, Hayama, Japan
[5]University of Zurich, Functional Genomics Center Zurich, 8057, Zürich, Switzerland
[6]Kanazawa University, Advance Science Research Center, Division of Functional Genomics, 920-8640, Kanazawa, Japan
[7]Bogor Agricultural University (IPB), Faculty of Forestry, 16680, Bogor, Indonesia
[8]Gadjah Mada University, Faculty of Forestry, 55281, Yogyakarta, Indonesia
[9]Kyoto University, Graduate School of Agriculture, 606-8502, Kyoto, Japan

Dipterocarpaceae is an ecologically and economically important tree family in the Southeast Asian tropical rainforest, and consists of >500 species. We previously conducted RNA-seq analysis of Shore beccariana and showed that general flowering in 2009 was preceded by the upregulation of drought response genes. To further understand the genetic basis of dipterocarp ecology, we assembled the genome of Shorea leprosula, which is one of the most widely distributed dipterocarp species in Southeast Asia (Malay Peninsular, Borneo Island and Sumatra). Although the conservation status of the species is categorized as least concern in the Malaysian Plant Red List, global assessment by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species has recognized the species as endangered due to its reduced population as a result of extensive logging activity for its light red Meranti timber. The genome assembly contains >53,000 protein-coding genes with approximately 190X coverage of its diploid genome (2n=14; ~450Mbp). Many of these protein-coding genes had similar paralogous genes, and the Ks distribution for the paralogous gene pairs suggested a whole-genome duplication event. Gene ontology enrichment showed that both paralogs of a large number of drought response genes were retained since the duplication event. These paralogues might have contributed to the adaptation of dipterocarps in different water availability conditions from aseasonal to seasonal tropics. Our findings suggest that drought has been an important environmental factor for the dipterocarps despite relatively high average rainfall, and highlight the concern of recently increasing drought. The population structure and selection pressure acting on them revealed by genome resequencing would be valuable to design strategies for conservation and economical utilization.

O31-08 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Local population size, resistance gene diversity, and negative density dependence in tropical tree species

JAMES MARDEN[1], SCOTT MANGAN[2], MARK PETERSON[3], ERIC WAFULA[1], HOWARD FESCEMYER[1], JOSHUA DER[4], CLAUDE DEPAMPHILIS[1], LIZA COMITA[5]
[1]Pennsylvania State University, Biology, 16802, University Park, PA, USA
[2]Washington University, Biology, 63130, St. Louis, MO, USA
[3]Viterbo University, Biology and Mathematics, 54601, La Crosse, WI, USA
[4]California State University, Biological Science, 92834, Fullerton, CA, USA
[5]Yale University, School of Forestry and Environmental Studies, 06511, New Haven, CT, USA

Pathogens shape diversity and species abundances in plant communities, as shown in recent studies where locally rare species were more sensitive to pathogen-mediated negative density dependence (NDD). Here we demonstrate that allelic diversity in pathogen resistance (R) genes is closely related to local population size in six species of rainforest trees on the Forest Dynamics Plot in Panama. Maternal seedling cohorts of less abundant tree species with reduced R gene diversity were more co-susceptible to colonization by pathogenic fungi and had reduced defense gene induction following exposure to live soil. There was no evidence for general inbreeding deficiencies, as locally rare species showed no reduction in transcriptome-wide polymorphism or hormonally induced defense responses downstream of pathogen recognition. These results show that disproportionate reduction in diversity of allele-rich R genes by genetic drift increases pathogen co-susceptibility and can explain the previously demonstrated dependence of NDD on local population size. We suggest that genetic drift in small local populations initiates a feedback loop that hinders locally rare species from increasing in abundance. This loop is escapable by immigration of additional R gene alleles from larger regional populations.

O31-09 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Dipterocarp seedlings growth and mortality in natural forest: Importance of local pattern of genetic diversity and genetic relatedness for forest natural regeneration and conservation

CLAIRE TITO DE MORAIS[1], CHRISTOPHER KETTLE[1], CHRISTOPHER PHILIPSON[1], COLIN MAYCOCK[2], DAVID BURSLEM[3], EYEN KHOO[4], JABOURY GHAZOUL[1]
[1]ETH Zurich, Ecosystem Management, 8092, Zurich, Suisse
[2]Universiti Malaysia Sabah, International Tropical Forestry, Faculty of Science and Natural Resources, Kota Kinabalu, Malaysia
[3]University of Aberdeen, Institute of Biological and Environmental Sciences, AB24 3UU, Aberdeen, UK
[4]Forest Research Center, Sabah Forestry Department, 90715, Sandakan, Malaysia

Processes that maintain high tree species diversity within tropical rain forests continues to be a much debated topic. Alternative but not mutually exclusive mechanisms include segregation of the light environment, and negative density dependence mediated by biotic interactions. Genetic diversity and mating patterns among trees might also contribute to the performance and mortality of individual progeny among tropical tree communities, yet these are rarely considered in tree species coexistence studies. We explore how trade-offs in growth and mortality, mediated through seedling genetic relatedness explain variations in performance and survival rates and thereby contribute to the maintenance of species diversity through co-existence mechanisms. We present two and a half years of data on seedling growth and mortality in 1485 seedlings from four dipterocarp species. Using individual multilocus heterozygosity (sMLH) and pairwise kinship coefficients (LRI) we examine the effects of genetic diversity and relatedness on growth and survival in an undisturbed Bornean tropical forest. We hypothesized that more genetically diverse populations of co-occurring seedlings have greater survival and performance. We found that while SMLH is not a good predictor of growth rates, it is nevertheless negatively associated with mortality. In three of the four species, high seedling relatedness was correlated with low seedling mortality but also low growth. Our results suggest that genetic factors are likely to be important for understanding mechanisms of dipterocarp species coexistence in dipterocarp forests.

O31-10 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Extensive seed and pollen dispersal and assortative mating in the rainforest tree Entandrophragma cylindricum (Meliaceae) inferred from indirect and direct analyses

FRANCK MONTHE KAMENI[1], OLIVIER HARDY[1], JEAN-LOUIS DOUCET[2], JUDY LOO[3], JÉRÔME DUMINIL[4]
[1]Université libre de Buxelles, Faculté des Sciences, Service Evolution Biologique et Ecologie, 1050, Bruxelles, Belgique
[2]Université de Liège, Foresterie tropicale, Gestion des Ressources Forestières, BIOSE, Gembloux Agro-Bio Tech, 5030, Gembloux, Belgique
[3]Bioversity International, Headquarters, Via dei Tre Denari, 00057, Rome, Italy
[4]Bioversity International, c/o CIFOR Central Africa Regional Office, 2008, Yaoundé, Cameroun

Background: Understanding patterns of gene flow of rainforest species is a key requirement for implementing species management and conservation in light of global changes. Pollen and seed dispersal are key processes affecting the demographic and evolutionary dynamics of plant species. Limiting gene flow can lead to reduced effective population sizes which, in turn, can cause serious inbreeding depression in plant species, especially in trees. We studied through direct and indirect genetic analyse the mating system, the extent of pollen and seed dispersal, and assortative mating in an insect-pollinated and wind-dispersed timber species, the African mahogany, Entandrophragma cylindricum (Meliaceae).
Method: Due to different types of analysis (direct and indirect), We sampled and genotyped (using nuclear microsatellite markers), adult trees, seeds and saplings, in a 400-ha study plot and along four forest trails extending outward the plot in a natural forest from East Cameroon.
Result: The species is mainly outcrossed (t = 0.925) and seeds from the same fruit are usually pollinated by the same father (correlated paternity, rp = 0.77). An average of 4.76 effective pollen donors (Nep) per seed tree contributes to the pollination. Seed dispersal was as extensive as pollen dispersal: mean dispersal distance in the study plot approached 600 m, and immigration rates from outside the plot to the central part of the plot reached 40% for both pollen and seeds.
Discussion & Conclusion: Extensive pollen- and seed-mediated gene flow is further supported by the weak fine-scale spatial genetic structure (Sp statistic = 0.0058), corresponding to gene dispersal distances (σg) reaching c. 1500 m. Surprisingly, the relatedness between mating individuals was higher than expected by chance according to pollen dispersal distances. We hypothesize that this assortative mating might result from a genetic control on flowering phenology, a phenomenon of potentially important evolutionary and management significance.

O31-11 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Welcome back! Genetic restoration of a tropical flagship tree species

SASCHA A. ISMAIL[1], DAVID F.R.P. BURSLEM[1], COLIN R. MAYCOCK[2], EYEN KHOO[3], RICHARD MAJAPUN[3], YUJI ISAGI[4], YOSHIHISA SUYAMA[5], YU MATSUKI[5], CHRIS J. KETTLE[6]
[1]University of Aberdeen, School of Biological Sciences, AB24 3UU, Aberdeen, UK
[2]Universiti Malaysia Sabah, Faculty of Science and Natural Resources, 88400, Kota Kinabalu, Malaysia
[3]Forest Research Center, Biotechnology Unit, 90715, Sandakan, Malaysia
[4]Kyoto University, Graduate School of Agriculture, 606-8502, Kyoto, Japan
[5]Tohoku University, Graduate School of Agricultural Science, 989-6711, Miyagi, Japan
[6]ETH Zurich, Institute for Terrestrial Ecosystems, 8092, Zurich, Switzerland

We applied a range of conservation genetic approaches combined with field surveys of size structure and reproductive success to provide essential knowledge for conservation and recovery of until recently thought extinct tree species Dipterocarpus lamellatus. After 4 years of phenology survey only the two largest individuals fruited in 2015 suggesting that the remaining ten trees are not yet of reproductive size. Using the latest next generation MIG-sequencing we genotyped all known extant adult and pole trees at 143 SNPs. Additionally we genotyped all individuals and a sample of 60 nursery grown seedlings and seed at ten microsatellite loci. Our results suggest that the extant poles are not offspring of the extant trees, underlining their importance to the overall genetic diversity despite elevated inbreeding. With paternity analysis of seed and nursery raised seedlings we investigate if there are more unknown trees in this difficult terrain. We discuss the practical and genetic challenges faced by such rare but important flagship tree and how molecular approaches can better inform in-situ and ex-situ conservation.

O31-12 – S31 *Next generation forest science, managing and restoring tropical forest genetic resources*
Wednesday 22 June / 08:30-12:00 – Pasteur

Genetic resource protection in neglected tropical forests: the value of dryland forest trees

DAVID ODEE[1], STEPHEN CAVERS[2]
[1]Kenya Forestry Research Institute (KEFRI), Biotechnology Laboratory, 20412-00200, Nairobi, Kenya
[2]NERC Centre for Ecology and Hydrology, CEH Edinburgh, EH26 0QB, Penicuik, United Kingdom

Background: Tropical dryland forests (TDF, viz. woodlands, shrublands, thickets and wooded savannas) are important refuges for biodiversity, and may contain levels of floristic diversity comparable to those of tropical rainforests. They are highly threatened due to human dependency on wood and non-wood products, exacerbated by often extreme and variable climatic conditions. In sub-Saharan Africa (SSA) at least half a billion people live in or near TDF and directly or indirectly rely on the diversity of products and services for livelihoods (FAO 2014). In this region, TDF are exposed to many threats including fires, conversion to agriculture, unsustainable grazing, overharvesting, and climate change. These pressures result in degradation, fragmentation and eventual loss of biodiversity. Despite their significance, TDF have often received less scientific attention than moist tropical forests.
Next generation technologies and sustainable management
TDF are composed of a number of phytogeographical units with varying numbers of tree species of socio-economic and ecological importance (e.g. Miles et al. 2006). Studies of several tree species using neutral markers have revealed patterns of genetic structure that largely coincide with the phytogeographical units (Pock Psy et al. 2009; Allal et al. 2011; Odee et al. 2012). These studies identify present-day centres of diversity and endemism that probably represent ancient refuges for TDF tree species, generated by a process of climate-induced fragmentation that would have occurred in complementary phases to that of the moist forests.
Genetic resources in most dryland species are poorly understood, but need to be identified and protected. They should be given high priority because of their vulnerability to climate change and the particularly strong link between people and the ecosystem services they provide. Forest science, aided by next generation sequencing (NGS) tools, will allow us to make progress towards disentangling demographic histories and patterns of admixture, understanding the genetic basis of adaptation, developing novel and rapid approaches for breeding such as genomic selection, and forecasting how dryland species may respond to future climate change.
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O32-01 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteu

Europe, environmental norms and incentives

ALAIN KARSENTY
CIRAD, ES, 34398, Montpellier Cedex 5, France

Europe's "soft power" is based on norms, with a great emphasis on environmental ones. As the major commercial partner of more than 100 countries, norms adopted in Europe carry weight in non-European countries that seek to maintain or increase their market share. Europe's environmental norms are, therefore, considered well beyond Europe's boundaries.
Sustainable land-use and forestry norms have been particularly promoted by Europe, such as forest certification adopted in some European countries for public purchasing of timber. The most prominent initiative is the association between the EUTR (European Union Timber Regulation) and the FLEGT (Forest Law Enforcement, Governance and Trade) initiative under which Voluntary Partnership Agreements (VPAs) have been proposed to timber-exporting tropical countries. VPAs call for ensuring the consistency of national laws, propose an independent auditing of the national system of legality verification and a bilateral commercial agreement allowing timber with FLEGT authorisation to be imported in the EU without need for proof of due diligence. The tandem EUTR-FLEGT/VPAs also impact bilateral commercial relationships between, say, China and Indonesia, as Chinese's furniture made with Indonesian timber might be exported to the EU. As a consequence, some Chinese exporters are endorsing certification for their supply chains, and contribute to the diffusion of such standards in non-EU-markets.
EU Biodiversity Strategy 2020 states that "the EU will take measures to reduce the biodiversity impact of EU consumption patterns". This is why "zero-deforestation" commodity chains are the new issue involving Europe and some of its largest multinational corporations. Such commitments will have a worldwide impact and competitors are forced to endorse the same ones.
But the main difficulty for Europe will be to go beyond the formal endorsement of norms. FLEGT/VPAs implementation has been delayed, and no FLEGT authorisation has yet been delivered. In Indonesia, zero deforestation is contested by unions of small-medium oil palm producers, and challenged by local governments, in spite of government commitment. For tropical countries to endorse standards, Europe relies on a simplified version of the "theory of incentives", assuming stakeholders will become aware of the collective benefits they could expect. Unfortunately, the political economy dimension of the decision processes is more complex.

O32-02 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Globalised drivers of land use changes on tropical forest frontiers: the concept of 'telecoupling' and its operationalisation in land system science

PETER MESSERLI, FLURINA SCHNEIDER, JULIE ZÄHRINGER
University of Bern, Centre for Development and Environment, 3012, Bern, Switzerland

Landscapes on forest frontiers in the humid tropics provide powerful examples of the challenge to reconcile human development with increasingly evident planetary boundaries. These social-ecological systems not only have to meet the immediate livelihood needs and the broader development aspirations of their local populations. They are also expected to ensure the complex mix of ecosystem service flows that support human well-being locally and provide environmental benefits worldwide. At the same time, global forces have come to outweigh local determinants of land use change in these landscapes. Driven by demands for agricultural expansion and intensification, fuel, carbon sequestration, biodiversity conservation, and more, these forces consist of combined socio-economic and environmental interactions between two or more distant socio-ecological systems. Land change scientists have recently conceptualized this phenomenon under the term «telecoupling".
Current research endeavours seek to operationalize this new concept with a view to overcome major methodological and empirical research gaps. This paper reports on one such research project, which analyses the effects of telecoupling on forested landscapes in Southeast Asia and Africa and explores potentials for transformations towards sustainable development. First we will reveal major challenges and potential pitfalls of the telecoupling concept relating to questions such as (i) what are meaningful boundaries of social-ecological systems that allow us to define what is considered in- and outside? (ii) how can we avoid the holistic trap where everything is connected to everything? (iii) what entry points do we chose for our analysis, is it a social-ecological system or a connecting flow? We will then illustrate that these pitfalls can only be avoided, if the telecoupling challenge is closely related to the normative question of sustainable development. Only by focusing on land use processes that represent key sustainability challenges and by systematically exploring the winners and losers of such dynamics are we able to make the necessary analytical choices needed to avoid arbitrariness of focus and the holistic trap. Once these choices are transparent, we can design the research approach and adequate methodologies. We will present concrete examples from the forested landscapes in Northern Laos to demonstrate how these conceptual insights are currently operationalised.

O32-03 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Europe is ruling the new global wood-energy market: what potential impact on Central African forest sector ?

LAURENT GAZULL
CIRAD, Environnement et sociétés, 34398, Montpellier, France

Today, many European governments are setting up policies to promote wood energy as part of their plans to meet the EU ambitious target of 20% of energy consumption from renewable sources by 2020. In its various forms, from sticks to chips and pellets, wood accounts for about half of Europe's renewable-energy consumption. Analysts forecast that demand will increase at an annual rate near 5% until 2030. In 2014, Europe consumed 16m tonnes of wood pellets. On current trends, this demand will rise to 25m-30m a year by 2020. Europe does not produce enough timber to meet that extra demand. At the moment, EU is the largest wood energy market in developed countries and to supply its demand it is already importing huge quantities of fuelwood mainly from the USA, Canada and Russia.
But the major exporters (Canada and USA) could soon be interested in using pellets for their own electricity needs replacing coal and the source could quickly dry up. Apart from the Republic of South Africa, Sub-Saharan Africa, still do not participate in this market. Yet the resources, particularly in Central Africa are significant. Central African countries have the potential to produce enough biomass that even after covering growing domestic energy demands, a net surplus of biofuel can be sustainably produced.
Loggers and African processors begin studying the possibility of producing and exporting pellets and charcoal to Europe. This new market has the potential to completely revolutionize the current market of timber, its geography and its logging standards. First, the prices of wood energy are constantly increasing, and some economists expect the world price of fuelwood and industrial roundwood to converge in 2030. Then the wood energy market is not very demanding on the quality of wood; all wood is good to burn: sawmill residues, forest wastes, declassified logs, and secondary species. Then the woodfuel market is not very demanding on production standards, although voluntary standards are emerging. And finally pellet is a product that allows to concentrate the energy and reduce transportation costs. It thus allows to make profitable remote production sites.
This presentation aims to give a brief overview over the trade in woodfuel at global scale and to highlight threats and opportunities for Central African forest sector that the increasing European demand may cause.

O32-04 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Reconciling Conservation and Development: The case of oil palm in Cameroon

NGOM EMMANUEL PIERRE, LEVANG PATRICE
[1]Ministry of Agriculture and Rural development, Department of Agricultural Development, 14014, Yaoundé, Cameroon
[2]IRD/CIFOR, Montpellier, France

For many years, Europe intervenes in different ways to promote sustainability criteria for many agricultural and forestry products coming from developing countries. This european intervention is manifest at both ends of the trading chains:
i) In European countries through importation restrictions (bans, quotas, tariff barriers) of products which does not meet the required norms;
ii) In producing countries by supporting campaigns of environmental NGOs like WWF, ZSL, Greenpeace etc or through oriented bilateral or multilateral funding like KfW, GIZ, AFD, DFID, PROFOREST, TFT, TFA2020.
European interventions target various products considered es vital for the Cameroonian economy (timber, cocoa, coffee, palm oil, natural rubber). Even when the trading chains are not directly targeted, the conservation agenda of most environmental NGOs opposes the expansion of agro-industrial plantations at the expense of forests. As such, European interventionism is often considered as a way to impose conservation agenda of developed countries upon developing countries, without taking in account the legitimate aspiration for development of the South.
While sustainability is essential for the whole planet, the search for sustainability should not prevent development in the South.
Reconciling conservation and development should be the ultimate objective to reach by all parties in order to have a sustainable and equitable development. The example of the oil palm sector in cameroon shows that such an objective is not an utopian view.

O32-05 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Impact of Roundtable on Sustainable Palm Oil certification on deforestation and fire in Indonesia

KIMBERLY CARLSON[1], ROBERT HEILMAYR[1], HOLLY GIBBS[2], PRAVEEN NOOJIPADY[3], DAVID BURNS[4], DOUGLAS MORTON[3], NATHALIE WALKER[4], GARY PAOLI[5], CLAIRE KREMEN[6]
[1]University of Hawaii, Natural Resources and Environmental Management, 96822, Honolulu, USA
[2]University of Wisconsin, Department of Geography, 53706, Madison, USA
[3]NASA Goddard Space Flight Center, n/a, 20771, Greenbelt, USA
[4]National Wildlife Federation, National Advocacy Center, 20006, Washington, USA
[5]Daemeter Consulting, n/a, 95501, Eureka, USA
[6]University of California, Department of Environmental Sciences, Policy, and Management, 94720, Berkeley, USA

Voluntary sustainability standards seek to improve socio-environmental outcomes associated with commodity production, especially in regions with low environmental governance. Despite the optimism associated with these voluntary policies, there has been almost no rigorous quantification of their efficacy. Here we assess the impacts of Roundtable on Sustainable Palm Oil (RSPO) certification on the environmental performance of palm oil producers. Palm oil composes about a third of the global edible oil supply and oil palm expansion is been a leading cause of tropical deforestation in Indonesia. Palm oil is also the most rapidly growing certified agricultural commodity in the world, and most certified palm oil is sold to Europe. Under RSPO certification, producers are prohibited from clearing primary forest and high conservation value areas after 2007, and are not allowed to use fire for land clearing. In light of these requirements, we assess whether RSPO certification leads to a reduction in deforestation and fires.
To tackle this question, we compile a comprehensive dataset of certified and non-certified oil palm concessions in Indonesia. Using remotely sensed measurements of deforestation and fire between 2000 and 2014, we compare the environmental performance of certified and non-certified concessions. We seek to control for the selection bias inherent in the adoption of voluntary policies through quasi-experimental methods. We employ a matched, fixed effects model to identify the average treatment effect on concessions participating in RSPO certification.
We find that RSPO certification significantly reduced rates of deforestation and fire incidence in Indonesian plantations. Certified plantations were established long before the average Indonesian plantation, indicating that producers have met RSPO requirements by certifying low-risk plantations.
Results suggest that RSPO certified palm oil embodies reduced deforestation and fire compared to conventional production, and that eco-certification can reduce deforestation. However, RSPO certification has reduced rather than eliminated deforestation. Additional progress will be necessary to achieve "zero-deforestation" supply chains for palm oil.

O32-06 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Cost, benefit and impacts of palm oil production: a cross-scale actor analysis

MALIKA VIRAH-SAWMY
Luc Hoffmann Institute, WWF International, Gland, Switzerland

The threats facing the conservation of biodiversity are increasingly tele-connected as they are driven by global relationships of demand, supply, investment, and trade. Despite increased understanding of the complexity of these relationships, conservation management activities are often conducted in insolation, focussed on a single place, and incongruent across scales. For example, much of the effort to support sustainable palm oil has focussed on encouraging producers to adopt sustainable practices without considering the intersection and impact other actors, such as investors, have with the supply chain and on natural resource depletion. In parallel, Europe accounts for only 10-20% of total global consumption of natural resources, but it is unknown to what extent actors on the continent are driving investment and trading decisions in the palm oil industry, therefore linking directly to environmental depletion and subsequent social impacts. NGOs working to address complex issues often find their responses limited by constraints in capacity. With regards to supply chain-driven biodiversity threats, this shortfall in capacity to respond to can be seen in common approaches that tend to place responsibility on local, geography stakeholders to act, and ignore or decouple the contribution to degradation from traders, investors and consumption actors in the supply chain. This decoupling results in the dispersed actors escaping responsibility for their part in the process as well as addressing only the locally realised symptoms of tele-connected biodiversity threats. Nowhere is this more present then in the oil palm industry. To illustrate importance of considering both local and global input into supply-chain biodiversity threat, we present results from a Luc Hoffmann Institute (LHI) Project that is attempting to analyse and compare the cost, benefit and impact of certification approaches for palm oil versus business as usual approaches. This project illustrates how cost, benefits and impacts manifest themselves across different scales for a variety of actors. Additionally, we will illustrate how a concurrent LHI project is developing a new place-based approach that will give more specific quantifiable metrics to link drivers and actors affecting supply-driven biodiversity loss for a given landscape. These metrics provide further clarity on the true contribution to biodiversity degradation of actors such as producers, retailers, investors, and traders in the supply chain. We show how both sets of project results can be used to support transformative change that benefits both the environment and society, at multiple scales and across a broad range of actors.

O32-07 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

No net loss of biodiversity? Mitigating development impacts and the future of tropical forested landscapes

FABIEN QUÉTIER[1], PAUWEL DE WACHTER[2], HÉLÈNE DESSARD[3], LAURÈNE FEINTRENIE[3], CLAUDE GARCIA[4]
[1]Biotope, International Affairs, 34140, Mèze, France
[2]WWF, Central Africa Regional Program Office (CARPO), 6776, Yaoundé, Cameroon
[3]CIRAD, Biens et services des écosystèmes forestiers tropicaux, 34000, Montpellier, France
[4]ETH Zurich, Forest Management and Development, 8092, Zürich, Switzerland

With biodiversity being lost at unprecedented rates, mitigating the impacts of development projects is a growing concern. International best practice indicates that projects located in natural habitats must achieve no net loss of biodiversity, or preferably a net gain. To do so, when development projects generate impacts on biodiversity that could not be sufficiently avoided or reduced, offsets must be designed and implemented to effectively and fully compensate for the residual loss of biodiversity, by generating measurable conservation gains elsewhere.
There are considerable technical and organizational challenges to designing and implementing biodiversity offsets, which must also respect the legal and customary rights of local populations. Offset frameworks have been put in place in several countries worldwide but, in many circumstances, it is financial institutions and multinational companies that require these approaches as part of their risk management strategies. As such, they represent an important external influence on the future of tropical forested landscapes. A further challenge, however, is that developing countries, eager to access their natural resources, don't all share this ambition.
We illustrate this with mining development in the tropical forest landscape which straddles the borders of Cameroon, Gabon and the Republic of Congo. Conservationists fear that the infrastructure being built to service an emerging iron ore province will reduce a large intact forest landscape to a mosaic of isolated protected areas no longer fit to conserve its mega-fauna or maintain large scale ecosystem processes. We use companion modelling techniques to build a model of the socio-ecological system, and develop future scenarios. In doing so, we map the role of various actors in making these futures possible.
A key conclusion is that managing the impacts of mining development requires a strategic and multi-sectorial landscape-level approach, rather than dealing with each separate project sequentially. We identify key enabling conditions for this to happen, including science-based knowledge and tools, and more effective institutions. These lessons are applicable to other large intact forest landscapes under threat from infrastructure and industrial development, and we discuss the role of international best practices in driving the future of these tropical forested landscapes.

O32-08 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

The role of commodities in tropical deforestation

LAEL K. GOODMAN, DOUG BOUCHER
Union of Concerned Scientists, Tropical Forest and Climate Initiative, 20006, Washington DC, USA

In recent decades, the majority of tropical deforestation has been caused by commercial actors growing commodity crops. Popular discourse emphasizes a large number of agricultural commodities as well as shifting cultivation and mining as being linked to high levels of deforestation. While many of these are historically or regionally influential, recent studies show that just four commodities: beef, soy, palm oil, and wood products cause the majority of global deforestation. Furthermore, the contribution of beef, both to deforestation and to global warming emissions far outweighs the contribution of the other three.
While some governments, such as Brazil, have taken steps to combat the commodity-driven deforestation, there is evidence to suggest that some of the reduction in deforestation has leaked to other ecosystems and other countries. Transnational corporations that deal in the key commodities are the entities that are most able to stem the tide of deforestation caused by global agriculture.

O32-09 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Sustainable production as the new standard, but we need convincing evidence.

MARIJKE VAN KUIJK
Environmental Biology, Biology, 3584CH, Utrecht, Netherlands

Background: Tropical forests are threatened by unsustainable timber subtraction and by the increasing production of food and biofuels. Several initiatives have been developed to reduce the negative effects of unsustainable production, including certification standards that claim sustainable or responsible production of resources. Many companies are taking responsibility for the sustainability of their supply chains by bringing certified products onto the market. However, the extent to which voluntary initiatives can fulfill public goals set by certification standards, remains to be seen.
A number of European initiatives have effectuated a higher market share of sustainably produced resources, however the European Union should take on a more forceful role to increase the sustainability of production and trade. For example, companies can be required to provide more transparency on their resource chains, or obligatory minimum standards could be set for imported products and resources. However certain barriers appear to prevent a scaling up of sustainable market shares. This relates to high costs for producers to achieve certification and implement improvements to meet certification standards, the lack of a level playing field for all market parties, and the lack of sufficient global demand for sustainably produced resources. One of the reasons for a low demand is that awareness of the impacts of certified production and sustainable trade is low, especially in production regions.
Method: Certification aims to promote sustainable practices through independent evaluation of management against a number of requirements that are generally described as Principles and Criteria (P&C). The Forest Stewardship Council (FSC) for instance, prescribes among others Reduced Impact Logging, riparian buffer zones and protected areas within forest management units for sustainable timber harvesting, while the Roundtable on Sustainable Palm Oil (RSPO) and the Round Table on Responsible Soy (RTRS) prohibit plantations on areas where there used to be, or still is, primary forest or high conservation value forest. They also promote the conservation of rare, threatened and endangered species.
Empirical evidence on the effectiveness of some of requirements of certification initiatives, like RIL and riparian buffer zones, exists. However, P&C are not always clearly defined, lack essential details and guidance, have insufficient rigor and are often open to national interpretations which affect the effectiveness of their implementation. This of course is a consequence of production areas being highly diverse around the globe, but also substantial variation is found within geographical regions. Furthermore management of production areas is highly dependent on ecosystem characteristics and management goals, and a huge number of stakeholders are involved. As a result it is often not clear from the P&C, how to implement certain management activities or how to manage them properly. For instance, the effectiveness of installing corridors depends on the size and the quality, not only of the corridor itself but also of the fragments that are connected.
Results: Based on the limited evidence that is available now it is generally agreed that certification does have positive effects on deforestation, degradation and biodiversity loss, at least for FSC and compared to conventional logging practices. These effects are however limited in scale and do not occur always and everywhere and the effects are not properly investigated at all locations. In general, impact assessments are based on secondary information or on stakeholder's perspectives, contain qualitative rather than quantitative data, and field-based studies are often not scientifically rigorous enough because they are many times small scale and not all impacts found in the field can, with certainty, be attributed to certification alone. On top of this, many certification initiatives are rather new and therefore results may not yet be measurable.
Discussion/conclusion: More attention must be given to monitoring, investigation and reporting, in order to more clearly demonstrate the added value of certification. We need more knowledge on the effects, positive and negative, including the conditions under which these were achieved. Reliable impact assessments are required to demonstrate the added value of certification systems and to ensure credibility in the eyes of buyers and consumers. This should contribute to an increasing demand for sustainable production and trade and thus certified products. However, sustainable trade should be part of a wider approach to sustainable production and consumption, in which attention is paid to increasing resource efficiency, searching for alternative resources with less environmental pressure and changes in consumption patterns. A uniform European purchasing policy with more binding obligations and a level playing field for companies, also seems appropriate. These initiatives will hopefully lead to sustainable production as the new standard.

O32-10 – S32 *Europe's role in driving the future of tropical forested landscapes*
Wednesday 22 June / 14:30-17:30 – Pasteur

Is certification the silver bullet to promote sustainable production of tropical commodities?

RENÉ VERBURG, PITA VERWEIJ
Utrecht University, Copernicus Institute of Sustainable Development, 3584 CS, Utrecht, The Netherlands

The ever increasing consumption of tropical commodities by European citizens, like coffee, cacao, soy, timber and biofuels puts strong environmental and socio-economic pressure on tropical lands. The impacts can be severe, ranging from deforestation, pollution, social exclusion and poverty. Certification of tropical commodities is seen as a measure to counteract these detrimental effects. Recent studies show that certified commodities do have potential to reduce environmental pressures, and can provide important ecosystem services at the landscape scale. Numerous certification schemes by different agencies have caused a modest increase in the share of certified products sold in European stores. However, the requirements of the associated standards can differ considerably and therefore not all certified products can be considered environmentally sustainable. Furthermore, most standards do not address indirect effects in terms of displacement of land use. In addition, mostly high-educated and environmentally aware consumers are interested in buying such products. The bulk of tropical commodities is still produced under environmental unfriendly and socially unjust conditions.

Solutions to promote sustainable production should therefore not rely entirely on an expected increase in the share of certified products. Governmental policies in the EU and in tropical countries, regulation and actions by private companies seem to be equally important. This requires knowledge on policy structure at the various governance levels, policy mechanisms and regulation. The question is also, whether shareholders can help pushing the environmental accounts of companies towards more sustainable production. Governments and society should therefore not only put frontrunners in the spotlight but also push stragglers to more sustainable production systems.

In this presentation we will discuss the effectiveness of certification of tropical commodities and the policy actions to be taken to increase sustainability aspects with lower environmental impacts on tropical rainforest.

O33-01 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
Wednesday 22 June / 08:30-09:30 – Einstein

Structure and robustness of a hyper-diverse seed dispersal network in Thailand

ALBERT-DAVIAUD AURELIE
Royal Botanic Gardens, Kew, Comparative Plant & Fungal Biology, RH17 6TN, Ardingly, United Kingdom

Background: Southeast Asia is considered a conservation priority region due to the strong deforestation it faces. The impact of the resulting defaunation on seed dispersal, a process essential for ecosystem dynamics, has already been observed. However, studies performed on plant-disperser interactions have mainly focussed on small subsets of species, giving an extremely limited overview of the impact of defaunation on actually complex seed dispersal networks. Here, for the first time, we 1) fully describe a highly diverse Southeast Asian seed dispersal network, and 2) test its robustness to defaunation.

Methods: We first performed a literature review to gather data on seed dispersal interactions between plants and animals in the Khao Yai National Park, Thailand. Then, we reconstituted the seed dispersal network. To study the network structure, we estimated its specialisation (H2'), modularity (Q) and nestedness (NODF). We highlighted species with important ecological roles according to their interactions within and among modules. Finally, we tested the network robustness to defaunation by simulating the extinction of threatened dispersers.

Results: The hyper-diverse seed dispersal network (61 animals and 287 plants) we have reconstituted is highly nested and modular. Taxonomy and morphology have a major influence on modularity. We observed that the largest frugivores tend to interact with the highest number of plants species, and macaques and gibbons play key roles for the coherence of the network. The network is robust to disperser extinctions: specialisation, nestedness and modularity did not change substantially. However, a certain percentage of plant species may be secondarily extinct after the extinction of threatened dispersers, and we observed that the removal of species such as macaques or gibbons led to the highest changes.

Discussion: Although this highly diverse network is robust to disperser loss, the extinction of large supergeneralists could trigger important changes in the ecosystem dynamics. Indeed, the effective replacement of large animals by smaller ones for seed dispersal seems to be very unlikely. Moreover, given the large contribution of supergeneralists to the network coherence, their extinction could be critical. Finally, the seed dispersal network studied could be similar to other networks occurring in Southeast Asia, and what happens there could be generalized and help us to predict the impact of defaunation in the region.

O33-02 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
Wednesday 22 June / 08:30-09:30 – Einstein

Western lowland gorilla and logging companies: a winning duo?

BARBARA HAUREZ[1], CHARLES-ALBERT PETRE[1], YVES BROSTAUX[2], CÉDRIC VERMEULEN[1], NIKKI TAGG[3], JEAN-LOUIS DOUCET[1]
[1]Gembloux Agro-Bio Tech, University of Liege, Laboratory of Forestry of Tropical and Subtropical Regions, 5030, Gembloux, Belgium
[2]University of Liege, Statistics, Informatics and Mathematics, 5030, Gembloux, Belgium
[3]Royal Zoological Society of Antwerp, Projet Grands Singes, Centre for Research and Conservation, 2000, Antwerp, Belgium

The critically endangered western lowland gorilla (WLG) disperses the seeds of many fruits. These seeds are often deposited at gorilla nest sites, in open-canopy habitats favorable for seedling growth and recruitment. However, considering anthropogenic disturbances, such as logging, gorillas and the directed seed dispersal services they provide are at risk. On the other hand, sustainably managed logging concessions are reported to harbor viable gorilla populations. If WLG provide effective dispersal of timber species, it would be of benefit to loggers for these ecological services to be preserved. In order to explore such interactions between the WLG and the timber industry, we (1) assessed the status of a WLG population in a logging concession, and (2) investigated their seed dispersal effectiveness for timber species.
We inferred the long-term viability of a gorilla population in a Gabonese logged forest, and the short-term impact of timber harvesting on this population. Gorilla density was estimated through three successive censuses: (1) 25 years after the first felling cycle, (2) six months and (3) one year after the second felling cycle. Seed dispersal effectiveness for timber species was estimated through gorilla fecal analysis and germination trials in a nursery.
The results suggested that a viable population of WLG could be maintained in selectively logged forests (< 2 cut trees ha-1). Indeed, although gorillas tend to flee areas being actively exploited for timber, their densities in logged forests can regain their initial levels, or even a higher one, within one year post-logging. Over a period of 20 months, the seeds of 59 plant species were found in gorilla feces. Nearly 20 % of the identified species (N=35) are of economic value because of their exploitation for timber. Analyzed fecal units contained on average 81.0 ± 107.8 intact seeds (0-566). Specific germination success varied from 0 to 100 %, with an average of 46 ± 36 %.
Sustainably-managed logging concessions may host viable populations of WLG. Considering the seed dispersal services provided for timber species and the unique directed-dispersal to open-canopy habitats, gorillas are implicated in the regeneration and maintenance of logged forests. Therefore, the generalization of sustainable logging would be beneficial both to the economical and the environmental value of tropical forests, thus providing an incentive for loggers and governments to prevent illegal hunting in concessions.

O33-03 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
Wednesday 22 June / 08:30-09:30 – Einstein

Contrasting tri-trophic food webs between primary and secondary tropical forest: role of species ecology and phylogeny

PETR KLIMES[1], FILIP HUSNIK[2], MICHAELA BOROVANSKA[1], PENNY J. GULLAN[3]
[1]Biology Centre of the Czech Academy of Sciences, Institute of Entomology, CZ 37005, Ceske Budejovice, Czech Republic
[2]Biology Centre of the Czech Academy of Sciences, Institute of Parasitology, CZ 37005, Ceske Budejovice, Czech Republic
[3]The Australian National University, Research School of Biology, ACT 2601, Canberra, Australia

Background: Insect and plant communities in tropical forests interact at multiple trophic levels. An example of a complex tri-trophic food web is the interaction of ants, their mutualistic Hemiptera and plants, which supports the high abundance of ants in tree canopies. However, these networks have not been studied in the tropics using knowledge of both species ecology and phylogeny. Moreover, little is known about how they change following anthropogenic disturbance.
Methods: We studied communities of tree-dwelling ants, their symbiotic scale insects (Hemiptera: Coccoidea) and tree hosts in primary and secondary rainforest in New Guinea. An area of 0.5-ha was searched for all occurrences of tri-trophic interactions in each of the two forests. We also recorded if interactions occurred outside or inside ant nests. Combinations of morphological and molecular approaches were used to identify the species and a molecular phylogeny was inferred for each of the three trophic groups.
Results: We observed 137 interactions in primary and 90 in secondary forest. The primary forest involved 19 ant, 16 scale insect and 32 tree species, whereas the secondary forest had 12 ant, 15 scale insect and 19 tree species. Overlap in all species between the two forests was low, with primary forest being dominated by interactions that occurred in ant nests, whereas interactions outside nests were common in secondary forest. Thus food webs were strongly associated with forest type and species ecology, but were not independent of phylogeny. The secondary forest had higher phylogenetic diversity of the symbionts and was dominated by invasive mealybug and coccid species, whereas native coccids dominated primary forest. Rather unexpectedly, relatively unspecialized networks were common in both forest types, with only slightly more specialized relationships among plant and coccoid lineages, than among ants and their symbionts. Most of the common species were linked to multiple phylogenetically distant partners.
Conclusions: Our results highlight the cryptic life-strategy of primary forest scale insects living in intimate relationship with ants in their nests, whereas secondary forest is characterised by prevalence of global pests. The networks are driven more by dominance of particular ant species and their symbionts than by coevolution with the plant hosts. Protection of the native tri-trophic food webs requires conservation of the whole primary forest communities.

O33-04 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
Wednesday 22 June / 08:30-09:30 – Einstein

Dispersal anachronisms in Madagascan legumes: the importance of the extinct megafauna

WOLFGANG STUPPY, AURÉLIE ALBERT-DAVIAUD
Royal Botanic Gardens, Kew, Comparative Plant & Fungal Biology, TW9 3AB, London, UK

Background: The extinction of Madagascar's megafauna between c. 2000 and 400 years ago had and continues to have consequences for biodiversity and a number of ecosystem processes, such as the dispersal of large-seeded plant species. Today, some species produce fruits and seeds obviously too big to be dispersed by living frugivores. These anachronistic species are missing their extinct mutualistic partners, such as giant lemurs and elephant birds. Here, we focus on dispersal anachronisms in endozoochorously dispersed members of the legume family (Fabaceae). In Madagascar, the Fabaceae are the third most species-rich flowering plant family, comprising 667 species of which 459 are endemic.
Method: We performed literature reviews to gather data about the plants (life form, fruit type, fruit and seed size, dispersal mode, number of seeds per fruit, habitat, distribution) as well their actual and potential animal dispersers (body size, diet, habitat, distribution), the latter including both living and extinct frugivores. We also added first-hand observations on herbarium specimens at the Royal Botanic Garden, Kew.
Result: The extant frugivorous guild in Madagascar is strikingly small compared to other tropical areas. Only 21 lemur, three bat, five bird and one tortoise species are mainly frugivorous (excl. granivores), and, among those, only some lemurs are able to disperse (i.e. swallow) very large (> 10 mm) seeds. Out of 505 native and endemic Fabaceae species in Madagascar, we were able to estimate the degree of dispersal anachronism of 481 species (95%). For the remaining species, sufficient information about fruits and seeds was unavailable. We found at least 17 species of Fabaceae in which the mismatch between fruit and seed morphology, and the physical limitations and sensory preferences of living fauna strongly indicates dispersal anachronism.
Conclusion: In Madagascar, many species from a wide range of plant families possess large pulpy fruits with big seeds. Therefore, it is a mere certainty that dysfunctional dispersal due to anachronism reaches far beyond the Fabaceae and, in fact, is a common problem affecting Madagascar's unique flora. It has been demonstrated that the loss of animal seed dispersers considerably increases the risk of extinction for plants with zoochorous fruits or seeds. Hence, apart from habitat destruction, dysfunctional seed dispersal is likely to be one of the main reasons why most of these species are now on the edge of extinction

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O34-01 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Conservation of tropical humid forest and wood supply in French Guiana: how sustainable forest plantation could help to respond to local demand in the future?

LILIAN BLANC[1], ERIC NICOLINI[2], DIDIER SABBADIN[3], HÉLÈNE MOREL[4], SANDRA NICOLLE[5], LAURENT DESCROIX[6], JACQUES BEAUCHÊNE[7]
[1]CIRAD, Environment & Societies, 34398, Montpellier, France
[2]CIRAD, BIOS, 97310, Kourou, French Guiana
[3]CIRAD, Environment & Societies, 34398, Montpellier, France
[4]CIRAD, BIOS, 97310, Kourou, French Guiana
[5]AgroParisTech, GEEFT, 34086, Montpellier, France
[6]ONF, R&D, 97300, Cayenne, France
[7]CIRAD, Environment & Societies, 97310, Kourou, French Guiana

In French Guiana, the forest sector (including private and public actors) will face strategic choices to respond to the increasing demand in wood supply for the coming decades. Indeed population in French Guiana is currently growing at a rate of around 2.5% per year and should exceed 500 000 inhabitants by 2050 leading to an increased consumption of material, energy and space. Tropical humid forests that cover 90% of the territory will be at the center of production and conservation concerns. Strategic choices, based on strong political decisions, include the volume of wood to be produced locally, the type of production (timber vs fuelwood) and the origin (plantation vs natural forest).
We conducted a work to analyze the opportunities of the forestry sector to meet these challenges. All wood supply is currently provided through the management of natural forests. An alternative issue would be to produce wood from forest plantation. Experimental tree plantations have been developed since the 70's in French Guiana. More than 30 local species and 26 exotic species have been tested to evaluate their potential in tree plantation. Up to now no plantation were established at lager scale in French Guiana.
We identified various scenarios to reach the wood supply by 2050. The scenarios were elaborated in two phases. First, we interviewed key actors of the forestry sector who gave their view on that perspective. It appeared that tree plantation is considered as a real opportunity for most of the actors. Second, species performance in tree plantation trials was carefully analyzed through mortality rates and tree productivity. Six species (four locals and two exotics) were identified with a high potential for sustainable forest plantation. Sustainability of natural forest management was also assessed based on the results provided by the Paracou experimental plot.
Four main scenarios were identified. Wood production is calculated for both managed forests and forest plantation and duration of each production cycle is provided. For each scenario, surface dedicated for natural forest management and tree plantation is estimated. Results are discussed in the light of the sparing and sharing strategies.
The four scenarios are providing a framework of discussions that could help the actors to focus on the long term and to imagine the likely impacts of current policy choices on conservation of natural forests.

O34-02 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Hypothesis driven research of linear infrastructure impacts and mitigation solutions

MIRIAM GOOSEM
James Cook University, College of Marine and Environmental Sciences, 4870, Cairns, Australia

Linear infrastructure including highways, roads and powerline easements cause multiple and varied impacts to the vegetation and wildlife of adjacent tropical rainforest. In tropical north Queensland, Australia, we have investigated these anthropogenic impacts over more than 25 years, with many of our predictions proving well-founded. The results of these investigations have provided information that has stimulated infrastructure construction and management organisations to design and incorporate a variety of measures designed to ameliorate these impacts. We have been able to test whether these mitigation measures provide successful outcomes through hypothesis-driven research that incorporates a Before/After Control/Impact (BACI) approach. Data have been collected that assess impacts prior to and post-construction of road upgrades and/or the mitigation measures. Investigations cover both the construction area and also similar areas where construction did not take place. In the majority of these projects, success hinges on a collaborative approach which involves infrastructure managers and designers, conservation scientists, the government organisations that manage parts of the region and the general public interested in conservation. Such collaborations naturally involve the consideration of compromises by all sectors. I will present the outcomes from several case studies that demonstrate how such collaborations can be successful, as well as discussing pitfalls that can restrict successful outcomes both for mitigation measures and also for collaborations. Our research has led to the development of best practice guidelines for planning, design and management of roads through rainforest, as well as the design of powerline easements which cause minimal impacts in rainforest habitat.

O34-03 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Applying question-driven research to oil development practices in a tropical rainforest: a case study in Gabon

LISA KORTE[1], ALFONSO ALONSO[2], HADRIEN VANTHOMME[2], FRANCISCO DALLMEIER[1], ELIE TOBI[1], MIREILLE JOHNSON[1], ANGELIQUE TODD[1]
[1]Smithsonian Conservation Biology Institute, Center for Conservation and Sustainability, Gamba, Gabon
[2]Smithsonian Conservation Biology Institute, Center for Conservation and Sustainability, 20560, Washington, US

The Gamba Complex of Protected Areas in the equatorial country of Gabon is a mosaic of national parks and protected areas with oil and forestry concessions. The habitat includes lowland tropical forest, savannas, wetlands, freshwater lagoons, and a coastline where the rainforest meets the sea. The Gamba Complex has abundant wildlife populations, including charismatic megafauna such as elephants, gorillas, chimpanzees, and hippos. In partnership with oil company Shell Gabon and in collaboration with the Government of Gabon, the Smithsonian Conservation Biology Institute applies scientific research, conservation, and resource management tools for the benefit of humans and wildlife in the Gamba Complex. Initial assessments documented biodiversity in the national parks and in oil concessions. These surveys laid the ground work for long-term scientific studies, such as forest dynamics and the social and spatial organization of elephants, to evaluate the response of flora and fauna to human activities including those by extractive industries. Studies that produced data useful for making management decisions include 1) elucidate wildlife distribution and movement patterns to optimize placement of wildlife crossing structures on roads, 2) document elephant raiding behavior to propose deterrent solutions and reduce the potential for human-elephant conflict, 3) model snaring and logging spatiotemporal patterns in the landscape to increase the effectiveness of anti-poaching patrols on oil concessions, and 4) monitor tree long-term growth in a 25-ha forest plot to improve methods for measuring carbon storage, which can be used for future offsets. This case study is a model for how conservation biologists, using scientific data, can work with extractive industries to improve development practices with a positive impact on biodiversity conservation.

O34-04 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Improving Carbon Stock Calculations in the Amazon: a case study from the Bolivia

SARA EDWARDS[1], ANA MARIA CARRION-CUELLAR[2], BENTE KLITGAARD[1], WILLIAM MILLIKEN[1], ALEJANDRO MURAKAMI[2], SILVIA PEREZ-ESPONA[3], ALEX MONRO[1]
[1]Royal Botanic Gardens, Kew, Science, TW9 3AE, Richmond, UK
[2]Universidad Autónoma Gabriel René Moreno, Museo de Historia Natural Noel Kempff Mercado, Av. Irala #565, Santa Cruz de la Sierra, Bolivia
[3]Anglia Ruskin University, Animal & Environment Research Group, CB1 1PT, Cambridge, UK

Tropical forests play an important part in the global carbon cycle, through both carbon sequestration, and the release of carbon dioxide during deforestation. However, estimations of how much carbon is stored in tropical forests vary greatly, and the extent of the effects that different environmental conditions have on tropical forest carbon sequestration are currently little understood. Reforestation, as well as identifying and protecting areas with high accumulations of carbon could help to redress the balance between carbon emissions and carbon pools. Further fieldwork to collect data, and improvements to the calculation models are essential to enable the accurate offset of global anthropogenic greenhouse gas emissions with the carbon pools of the world. The Forest Future project, led by the Royal Botanic Gardens, Kew and funded by the Darwin Initiative (20-021), established six permanent one hectare plots in flooded and terra firme rainforest in the Bolivian Amazon. Each tree with a DBH (diameter at breast height) of ≥10cm was tagged, measured, mapped and identified. Within two of these hectare plots ten systematically randomly selected, 100m2 forest sub-plots were surveyed. Trees, shrubs, and lianas with between 5 and 10cm DBH were measured and identified. Wood samples from the ten dominant species in each hectare plot were collected and the carbon content calculated. The data collected was used to assess 1) the different methods used to calculate carbon stocks; 2) the quantity of carbon in the wood samples collected was compared with the records on DRYAD and RBG, Kew's wood density database, how much using averages affects the calculations; and 3) the effect of including plants with between 5 and 10 cm DBH on the amount of carbon calculated to be sequestered in a forest. The results found that including plants with a DBH between 5-10cm increased estimates of carbon by approximately 5%. The carbon content in the dominant species of trees in the Bolivian Amazon is significantly lower than the average recorded from DRYAD for Tropical America. The results from the equations for estimating tC/ha (tonnes of carbon per hectare) in forests are all significantly different, but the results between the sites were not significantly different.

O34-05 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Effects of silvicultural intervention on natural regeneration of tropical mountain forest in southern ecuador

JOHANA MUÑOZ[1], PATRICK HILDEBRANDT[1], SVEN GÜNTER[2], BERND STIMM[1], MICHAEL WEBER[1], REINHARD MOSANDL[1]
[1]Institution : Technische Universität München - Department : Lehrstuhl für Waldbau, D-85354 Munchen - Germany,
[2]Institution: Thünen Institute of International Forestry and Forest Economics, D-21031 Hamburg, Germany

Tropical mountain forests contain a high biodiversity and provide a variety of ecosystem services. However, they are also affected by unsustainable management, degradation and land use change. Therefore, concepts for sustainable management are urgently needed. In general, the dynamics of tropical mountain forests and the environmental and regeneration requirements of particular tree species are still little known. Information about effects of some silvicultural interventions on natural regeneration is often lacking. Thus, information about the dynamics of natural regeneration is necessary for developing guidelines for its restoration and sustainable management.
In 2004, a silvicultural experiment has been installed on an area of 13 ha in the tropical mountain forest of Southern Ecuador; three intensities of intervention were evaluated. Promising individuals of selected tree species have been released from their competitors in order to investigate the effects on the natural regeneration. The aim of this study was to assess the natural regeneration dynamics before and after silvicultural intervention, in order to provide appropriate timber harvesting guidelines. All the analysis were based on the measurements of ten years of monitoring permanent plots. A Generalize additive mixed models was used to test the differences in the richness, abundance and diversity over time between treatments.
The first results show us no interaction between silvicultural intervention and time (measurements over time), but there is an effect of time on the richness, abundance, and diversity of natural regeneration. This effect is displayed if we include spatial level more than temporary space. It is means, there is spatio-temporal interaction.
In general, is possible reduce negative effects on natural regeneration using different intensities of silvicultural intervention. There is a spatial temporal dynamics of natural regeneration that is important to consider in forest management to avoid impacts on biodiversity.

O34-06 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Forest users' perceptions influencing community participation in community forests management: A case study of Nepal

NEGI SWATI[1], GARCIA CLAUDE[1], THUY PHAM THU[1], KARKY BHASKAR[1]
[1]ETH Zürich, Deaprtment opf Environmnetal Systems Science, 8092, Zürich, Switzerland
[2]CIFOR, CIFOR, 122414, Bogor, Indonesia
[3]ICIMOD, ICIMOD, 3226, Kathmandu, Nepal

The quest for win-win solutions, seeking both social and ecological benefits continues to shape the evolution of collective action in forest management. Community forestry (CF) implies the devolution of powers to the locals by the State for use and management of forests. Such governance arrangements have shown their capacity to significantly improve the status of forests and contribute to the livelihoods of forest-dependent people. However, in many cases CF is overlaid on top of socially heterogeneous communities. This not only makes it prone to elite capture and to policy failure due to lack of engagement or true devolution. In the case of forest carbon projects, established and embedded within the community forestry regime, it becomes important to re-emphasize community participation as a variable that reduces the risk of elite capture and contributes to equitable distribution of benefits Here we explore critical factors influencing community participation in forest management. We argue that forest users' perceptions shape their participation in CF and that the perceptions vary across heterogeneous communities. We specifically examine the relationship of forest users' perceptions of community forest management in Nepal, with their direct participation in the community forestry users' group (CFUG) activities. The study is based on a household survey, carried out with 180 forest users' households in 12 CFUGs in Chitwan, Nepal. A quantitative research methodology was designed for this research. The analysis of data uses GLM–Gaussian model to explore the relationship between participation as a dependent variable and other predictor variables involved. Our results indicate a statistically significant relationship between forest users' perception of CF and their participation in forest management. Furthermore, there is clear evidence that socio-economic variables, mainly caste and landholdings, have a statistically significant effect on participation. Our findings place an emphasis on understanding the forest users' perception to improve community participation in forest management. Policy makers, researchers and international funding agencies must incorporate forest users' perceptions in their interventions if collective action is to be successful.

O34-07 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Why history counts

STEPHAN PIETSCH
IIASA, ESM, 2163, Laxenburg, Austria

This work will provide evidence for ergodic to non-ergodic transitions Congo basin rainforests via application of a validated biogeochemistry model. Using a climate gradient from W to E, ergodic model behavior is shown for a virgin forest refuge, non-ergodic behavior for a nowadays forest savannah mosaic and ergodic behavior again for large open savannahs. Additionally the occurrence of hysteresis related to the prevailing initial vegetation will be demonstrated, whereby the non-ergodic phase along the climate gradient is shown to be more extensive if rainforest was the original vegetation as compared to rainforest establishing on non-forest sites.
Additionally, probabilistic resilience landscapes for the Congo Basin rainforest biome will be presented: In a first step the occurrence of tipping points will be related to climate features. Second, spatial resilience landscapes for the Congo Basin will be provided using present climate conditions. In a third step the concept of temporal resilience landscapes will be developed along the patch level life cycle dynamics of the Congo basin rainforest biome.
Next, the combination of ergodic to non-ergodic transitions – sometimes referred to as catastrophic shifts in ecosystems – will be put into context with the changing distribution patterns of rainforest and savannah over the course of the Holocene; and finally, impacts of forest management and land use decisions will be assessed.

O34-08 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Spatial distribution of Bertholletia excelsa in selectively logged forests of the Peruvian Amazon: Can historical disturbance explain juvenile spatial patterns?

CARA A. ROCKWELL[2], MANUEL R. GUARIGUATA[1], MARY MENTON[3], ERIKS ARROYO QUISPE[4], JULIA QUAEDVLIEG[1], ELEANOR WARREN-THOMAS[5], HAROL FERNANDEZ SILVA[4], EDWIN EDUARDO JURADO ROJAS[4], JOSÉ ANDRÉS HIDEKI KOHAGURA ARRUNÁTEGUI[4], LUIS ALBERTO MEZA VEGA[4], ROGER QUENTA HANCCO[4], OLIVIA REVILLA VERA[4], JONATAN FRANK VALERA TITO[4], BETXY TABITA VILLARROEL PANDURO[4], JUAN JOSÉ YUCRA SALAS[4]
[1]Center for International Forestry Research, Lima, Perú
[2]International Center for Tropical Botany, Department of Earth and Environment, Florida International University (FIU), Miami, FL, USA 33199
[3]Solutions & Evidence for Environment & Development (SEED) 106 Cowley Rd, Oxford OX4 1JE, UK
[4]Universidad Nacional Amazónica de Madre de Dios (UNAMAD), Facultad de Ingeniería Forestal y Medio Ambiente, Puerto Maldonado, Madre de Dios, Perú.
[5]Centre for Ecology, Evolution and Conservation, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, United Kingdom

Brazil nut (Bertholletia excelsa H.B.K., Lecythidaceae) favors tree-fall gaps, possibly contributing to the aggregated spatial patterns often observed in unlogged forests. Very little is known, however, about the spatial distribution pattern and density of Brazil nut trees in logged stands. Association of juvenile stems with former gaps might be strong, a trend that could have important implications for the health of Brazil nut populations. We asked the following questions: (1) What are the densities and spatial distributions of Brazil nut juveniles (10≤ DBH<40 cm) and adults (≥ 40 cm DBH) in selectively logged forest; (2) What is the spatial relationship between adults and juveniles; and (3) What is the spatial relationship between juveniles (10≤ DBH<30 cm) and cut stumps (≥ 10 years)? We conducted a survey in three logged Brazil nut concessions in Madre de Dios, Peru in order to identify adult and juvenile Brazil nut stems as well as cut stumps. We then described the spatial patterns of juvenile and adult trees as well as the spatial relationships between a) juveniles and adults, and b) juveniles and cut stumps using statistics derived from Ripley's K function. Juveniles were aggregated in all three concessions. Results for adult populations in two concessions failed to reject the null hypothesis of a random distribution, while the third concession demonstrated the existence of aggregation among trees ≥ 40 cm DBH. There was no attraction between juveniles and adults. Juvenile densities do not deviate from population trends reported in unlogged sites in the Southwestern Amazon region, despite the long history of anthropogenic disturbance. We also did not find an attraction between juveniles and old cut stump locations, suggesting that the observed juvenile clustering patterns must be related to other anthropogenic events and biophysical factors. Our results provide a better understanding of Brazil nut population structure in logged forests in Southwestern Amazonia, particularly for assessing the status of juvenile trees, a critical size class for multiple use forest management systems.

O34-09 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Fate of Bertholletia excelsa populations under reduced-impact logging and Amazon nuts gathering: a multiple use forest management perspective

MARLENE SORIANO[1], MARIELOS PEÑA-CLAROS[2], CRISTINA BARBER ALVAREZ-BUYLLA[2], PIETER A. ZUIDEMA[2], JUAN CARLOS LICONA[1], NATALY L. ASCARRUNZ[1], GODEFRIDUS J. M. MOHREN[2]
[1]Instituto Boliviano de Investigación Forestal, NA, Po.Box 6204, Santa Cruz de la Sierra, Bolivia
[2]Wageningen University, Forest Ecology and Forest Management Group, 6700AA, Wageningen, The Netherlands

The castaña or Brazil nut (Bertholletia excelsa, hereafter referred as Amazon nut) is remarkable for its high economic value amongst forest products derived from natural forests. Logging and Amazon nut gathering are two human activities that threaten the sustainable production of Amazon nut. Therefore, we assessed their long-term effect on Bertholletia populations along a gradient of harvest intensity.
This study was carried out in 24 household forests in the Bolivian Amazon. We established three, 2-ha transects in each household forest, making a total of 72 ha. Household forests varied on their logging and Amazon nut gathering intensity. Logging intensity was calculated as the relative percentage of the transect-area disturbed by logging (i.e., logging gaps, access roads, skidder trails, and log landings). Amazon nut gathering intensity was calculated as the percentage of fruits harvested from reproductive trees found within the transect area. All Bertholletia individuals found in the transects were measured in height or diameter, and were monitored for one year. Vital rates (i.e., growth, recruitment, survival and reproduction rates) were calculated and used to build a size-based matrix model. The matrix was then used to assess 16 scenarios with varying intensity of Amazon nut gathering (0, 30, 60, and 90%) and logging (0, 10, 20, and 30%).
The projected Bertholletia population growth rate declined for all tested scenarios; i.e. had a lambda <1. Over 100 years, all scenarios showed a decrease in population density. However, some scenarios of harvesting outperformed the scenario with zero, i.e., Amazon nut gathering and logging, intervention. The most favorable ones were: two scenarios with high Amazon nut intensity (60 and 90%) and no logging, and one scenario with 90% Amazon nut gathering and 10% logging disturbance.
These results indicate that mainly high (60 - 90%) Amazon nut gathering intensity could potentially counteract Bertholletia population decline. Although, and since Amazon nut gathering intensity is associated to nut production, which in turn, increases with liana cutting (Kainer et al. 2014); these results should be viewed cautiously. We conclude thus that in a multiple use forest management scheme, the levels of harvesting need to be carefully defined. Additionally, silvicultural interventions are needed to counteract the population decline.

O34-10 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Differences of productivity in the Amazon rainforest: estimates with an individual-based forest gap model

EDNA RÖDIG[1], MATTHIAS CUNTZ[2], ANDREAS HUTH[1]
[1]Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modelling, 04318, Leipzig, Germany
[2]Helmholtz Centre for Environmental Research - UFZ, Department Computational Hydrosystems, 04318, Leipzig, Germany

Tropical forests are characterized by their high biodiversity and successional dynamics caused by natural disturbances. These can be captured well on small spatial scales with individual-based forest models. In land surface models, important information on forest structures often get lost by upscaling processes to larger scales such as the whole Amazon rainforest. Here, we regionalize an individual-based forest gap model without losing such important structural information and can thereby estimate spatial differences of productivity across the Amazon tropical forest.
We adapted the individual-based forest gap model FORMIND to several tropical forest sites in central Amazon in order to reproduce productivity, forest structure and biomass of different successional stages. We spatially adapted the mortality parameters of early, mid and late successional trees to replicate data from field studies spread over the entire Amazonian rainforest: specific wood density, above-ground biomass and canopy height. This resulted in the regionalized forest model FORMIND-Reg. The results of the regionalized forest model were related to estimates of canopy heights derived from remote sensing data. This enables to analyze productivity of the Amazonian at different successional stages.
The FORMIND model for the central Amazon reproduces mean observed productivity. Simulated productivity spatially variates throughout the Amazon rainforest and productivity correlates with the mortality rate of late successional trees. By combining the FORMIND-Reg model with remote sensing data, we are able to construct a map of the productivity of the Amazon rainforest with a spatial resolution of 1 km^2. We will use the Amazon productivity map to explore ecosystem relationships such as productivity-biomass or ecosystem reactions to natural or human-induced disturbances.

O34-11 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

The structure of tropical forests and sphere packings

FRANZISKA TAUBERT[1], MARKUS JAHN[2], HANS-JUERGEN DOBNER[3], THORSTEN WIEGAND[1], ANDREAS HUTH[1]
[1]Helmholtz Centre for Environmental Research – UFZ, Department of Ecological Modelling, 04318, Leipzig, Germany
[2]Karlsruhe Institute of Technology - KIT, Geodetic Institute, 76131, Karlsruhe, Germany
[3]University of Applied Science – HTWK Leipzig, Institute for Computer Science, Mathematics and Natural Sciences, 04277, Leipzig, Germany

Tree size distributions are an important outcome of classical forest inventories and have long been used for describing forest structures and for deriving other attributes like forest biomass. In the tropics, undisturbed forests often show a skewed decaying tree diameter distribution. Here, we present a physical approach for explaining tree diameter distributions based in stochastic geometry by interpreting forests as tree crown packing systems. A developed static forest packing model of tree crowns is tested for explaining observed size structures of two large forest inventories on Barro Colorado Island in Panama and Sinharaja in Sri Lanka (with a total area of 75 ha). The observed tree diameter distribution can be reproduced successfully as a result of a few simple principles, which are site-specific tree allometries, tree mortality, random placement of trees and competition for space. We further quantify that most trees grow up to a height of 30 to 50m contributing to a dense height layer of 60% filled space. Our approach is an important step towards identifying a minimal set of processes responsible for generating the spatial structure of tropical forests.

O34-12 – S34 *Free session: Tropical forest ecology, conservation and management*
Wednesday 22 June / 10:00-15:30 – Einstein

Climate seasonality limits leaf carbon assimilation and wood carbon storage in tropical forests

FABIEN WAGNER[1], BRUNO HÉRAULT[2], LUIZ E.O.C. ARAGÃO[3]
[1]National Institute for Space Research - INPE, Remote Sensing Division, 12227-010, São José dos Campos, Brazil
[2]CIRAD, UMR Ecologie des Forêts de Guyane, 97379, Kourou, France
[3]National Institute for Space Research - INPE, Remote Sensing Division, 12227-010, São José dos Campos, Brazil

The seasonal climate drivers of the carbon cycle in tropical forests remain poorly known, although these forests account for more carbon assimilation and storage than any other terrestrial ecosystem. Based on a unique combination of seasonal pan-tropical data sets from 89 experimental sites (68 include aboveground wood productivity measurements and 35 litter productivity measurements), their associate canopy photosynthetic capacity (enhanced vegetation index, EVI) and climate, we ask how carbon assimilation and aboveground allocation are related to climate seasonality in tropical forests and how they interact in the seasonal carbon cycle. We found that canopy photosynthetic capacity seasonality responds positively to precipitation when rainfall is < 2000 mm per year (water-limited forests) and to radiation otherwise (light-limited forests); on the other hand, independent of climate limitations, wood productivity and litterfall are driven by seasonal variation in precipitation and evapotranspiration respectively. Consequently, light-limited forests present an asynchronism between canopy photosynthetic capacity and wood productivity. Precipitation first-order control indicates an overall decrease in tropical forest productivity in a drier climate.

O35-01 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

Influence of past and present environmental heterogeneity on the ecology and biogeography of Western Ghats endemic tree species

RUKSAN BOSE[1], FRANÇOIS MUNOZ[1], B.R. RAMESH[1], RAPHAËL PÉLISSIER[2]
[1]Institut Français de Pondichery, Ecology, 605001, Pondicherry, India
[2]IRD, UMR AMAP, Ecologie et diversité des communautés végétales, 34398, Montpellier, France

Background: Environmental heterogeneity in the Western Ghats (WG) is expected to drive both the assembly of endemic trees in extant assemblages and their long-term evolutionary dynamics. We addressed how (i) ecological strategies of endemic trees vary along current environmental gradients, (ii) environmental variations have shaped species' distributions during the last glacial cycle, and (iii) their phylogenetic diversity varies across geographical and ecological space, under the influence of evolutionary processes.
Methods: We assessed species' traits related to reproduction, dispersal, and competitive ability, and characterized species potential distributions in present and past (Last Interglacial, LIG, Last Glacial Maximum, LGM) climatic conditions. We evaluated the extent of potential distribution changes through time, as a testimony of past pressures for migration, niche change or ecological plasticity. We quantified the phylogenetic diversity of endemic trees in mesoscale assemblages, which was expected to be lower in more stressful environments. We also tested the phylogenetic turnover of these assemblages with regard to geographic and environmental distances.
Results: We identified three distinct scenarios of species' responses to Quaternary climate changes– stability, contraction and shift. For high-elevation species, the cool, dry LGM was less restrictive than for medium-elevation and northern lowland species. Higher LIG seasonality restricted species requiring minimal seasonality. Phylogenetic diversity varied according to seasonality and historical climate stability, and was lower under longer dry seasons. The overall positive phylogenetic turnover was driven by annual rainfall and elevation gradients, but not space. High-elevation endemics were phylogenetically distinctive along the elevation gradient.
Conclusions: The results concur to highlight the key role of environmental gradients in the biogeography and ecology of WG endemic trees. Palaeoclimate modelling reveals the likely local persistence of most endemics over the last 120 kyr, and their large spectrum of bioclimatic preferences reflect pre-Quaternary evolutionary events. Analyses of phylogenetic diversity further points to lower diversity in stressful conditions, which may reflect functional convergence. An abrupt change in phylogenetic turnover along the elevation gradient underlines the distinct biogeographic and evolutionary backgrounds of low- and high-elevation species pools.

O35-02 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

Indian Myrtaceae refutes 'out-of-India' hypothesis however resurrects the Gondwana antiquity

RAY RAJASRI[1], RAMACHANDRA TV[1], RAY AVIK[2]
[1]Indian Institute of Science, Center for Ecological Sciences, 560012, Bangalore, India
[2]Ashoka Trust for Research In Ecology and Environment (ATREE), Suri Sehgal Centre for Biodiversity and Conservation, 560064, Bangalore, India

Background: Gondwana break-up is one of the key sculptors of the global biogeographic pattern including Indian subcontinent. However, the case of Indian floral legacy remains contentious and is shared between relicts from Gondwana and dispersal from neighbouring countries. Myrtaceae is identified as a Gondwanan family with endemic radiation across Indian Western Ghats. A conspicuous paleo-presence in Deccan Intertrappean bed strive to reconcile two contending hypothesis of diversification in India, namely 'biotic ferry' supporting Gondwanan relicts and south-east Asian affinity.
Methods: In this study, with fossil-calibrated phylogeny, ancestral area reconstruction, and comparing various dispersal models we have majorly reconstructed the biogeographic history of Indian Myrtaceae.
Results: Our findings depict paraphyletic clades of sub-families of older Leptospermoideae and younger Myrtoideae. It indicates an Australian origin of ancestor of Myrtaceae flaring up the Gondwana connection. It soon followed rapid diversification owing to dispersal to contagious landmasses. Indian members are mostly of relatively younger age.
Discussion and conclusion: Floral massing of India by Myrtean lineages seem to be mediated through long-distance oceanic dispersal in middle Eocene and Miocene and followed by a major overland dispersal during Miocene. However, compelling fossil evidences in the Deccan intertrappean bed and later fail to refute the Gondwanan inheritance. Binding together, we conclude that the Myrtean lineages swept out by Indian ferry were eventually extirpated by Deccan volcanism leaving a little or no trace of living Gondwanan link.

O35-03 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

Phylogenetic and molecular dating analyses of endemic trees to gain insights into the evolution of biodiversity in the Western Ghats-Sri Lanka biodiversity hotspot

NAGARAJU SHIVAPRAKASH[1], NIMAL GUNATILLAKE[2], SAVITHRI GUNATILLAKE[2], SELVADURAI DAYANANDAN[1]
[1]Concordia University, Biology Department, H4B1R6, Montreal, Canada
[2]University of Peradeniya, Botany Department, 20400, Peradeniya, Sri Lanka

The Western Ghats and Sri Lanka biodiversity hotspot is well known for its high endemicity and home to important genetic resources including wild relatives of many grain crops, fruits and spices. Although the flora of the Western Ghats and Sri Lanka is generally considered to be of African origin, the evolutionary relationships and phytogeography of the flora within the region remain poorly understood. We performed molecular dating and phylogenetic analyses of selected woody plants endemic to Madagascar, Sri Lanka, Western Ghats and Eastern Ghats to assess the evolutionary relationships and divergence times of geographically restricted taxa to gain insights into the biodiversity evolution and phytogeography within the Western Ghats and Sri Lanka biodiversity hotspot. The results of the analyses of available rbcL, matK and psbA-trnH sequences of 144 taxa representing seven families (Lauraceae, Myristicaceae, Annonaceae, Rubiaceae, Dipterocarpaceae, Phyllanthaceae and Euphorbiaceae) is generally in agreement with the Madagascar ancestry of the taxa. The comparison of species within genera revealed that Goniothalamus, Hopea and Glochidion species endemic to Western Ghats were ancestral to the corresponding sister species endemic to Sri Lanka. We will present our findings in the context of divergence times of both plant animal taxa in the region. At present, the availability of nucleotide sequences for taxa endemic to Western Ghats and Sri Lanka are limited. We highlight the gaps in the data need to be filled to gain detailed understanding of the evolution and phytogeography of the Western Ghats-Sri Lanka Biodiversity hotspot.

O35-04 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

Patterns of liana diversity in different forest types of the Western Ghats biodiversity hotspot

PANDI VIVEK[1], NARAYANASWAMY PARTHASARATHY[1], CHELLAM MUTHUMPERUMAL[1], S MUTHURAMKUMAR[1], PRIYA DAVIDAR[1], JEAN-PHILIPPE PUYRAVAUD[1], D MOHANDASS[2], NARAYANAN AYYAPPAN[3]
[1]Pondicherry University, Ecology and Environmental Sciences, 605014, Puducherry, India
[2]VHNSN College, Botany, 626001, Virdhunagar, India
[3]Pondicherry University, Ecology and Environmental Sciences, 605014, Puducherry, India
[4]Sigur Nature Trust, 643223, Nilgiris, India
[5]Xishuangbanna Tropical Botanical Garden, Plant Ecology and Evolution Research Group, 666303, Menglun, China
[6]French Institute of Pondicherry, Ecology, 605001, Puducherry, India

Background: The Western Ghats of India constitute one of the 34 global biodiversity hotspots on account of high species diversity and endemism, yet exposed to several threats that affect biodiversity. This paper analyses patterns of liana diversity in a range of (tropical upper montane to dry) Western Ghats forests.
Method: We compiled liana inventories (stems ≥ 1cm gbh) conducted in (42.4 ha) upper-montane forest (UMF), lower-montane forest (LMF), lowland evergreen forest (LLF), semi-evergreen forest (SEF) and seasonal dry forest (SDF) of the Western Ghats. Aboveground biomass (AGB) of inventoried lianas was calculated and compared across the forest types using allometric equation of Schnitzer et al. (2006). Species diversity and endemism was compared with that of trees.
Result: There were a total of 185 liana species representing 15960 individuals in different forest types of the Western Ghats. The mean liana basal area was highest in SDF and the aboveground biomass was greater in SEF and SDF. Overall, big lianas (≥ 15 cm gbh) in the Western Ghats forests comprised 78% of the total aboveground biomass. Endemism in lianas was lower than that of trees.
Conclusion: Liana distribution and basal area varied among different types of the Western Ghats. Role of large lianas in storing aboveground biomass is also highlighted.

O35-05 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

South-west Sri Lanka: a floristic refugium in South Asia

NIMAL GUNATILLEKE[1], SAVITRI GUNATILLEKE[1], PETER ASHTON[2]
[1]University of Peradeniya, Botany, 20400, Peradeniya, Sri Lanka
[2]University of Peradeniya, Botany, 20400, Peradeniya, Sri Lanka
[3]Harvard University, Organismic & Evolutionary Biology, MA 02138, Cambridge, USA

Background: In South Asia, south-west Sri Lanka alone represents a per-humid region, associated with leached clay-rich loamy soils of low-moderate fertility, where Mixed Dipterocarp Forests (MDF) harbour a number of signature taxa providing evidence of ancient plant migration routes from Gondwana to Laurasia. Among them, those endemic to Sri Lanka's ever-wet southwest are Hortoniodeae subfamily Monimiaceae and species of Axinandra (Crypteroniaceae), Trichadenia (Sterculiaceae); Cotylelobium, Stemonoporus and Shorea section Doona (all of Dipterocarpaceae). Palynological and phylogenetic evidence now confirm that the Malesian forest flora overwhelmingly immigrated from tropical Africa/Madagascar via South Asia possibly along an ever-wet equatorial corridor across a marine strait in middle Eocene (c. 45 Ma). This ever-wet climatic- and geological history has led to the evolution of a characteristic species composition and dynamics within SW Sri Lanka's forest communities.
Methods: We examined the patterns of floristic variation in each of three MDF sites using classification and ordination methods to analyse tree data collected in 62 random plots, each 0.25ha, along the altitudinal gradient. In addition, the 25 ha forest dynamics plot (FDP) established in Sinharaja World Heritage Site, contributes to addressing CTFS-ForestGEO network-wide issue of how species coexist within these hyper-diverse communities.
Results: Ecologically distinct floristic assemblages were revealed, i. among the three MDF sites as well as, ii. among the ridge-, slope-, and valley habitats of each forest site. In the FDP, >80% of the 125 species, with individuals >1 cm dbh and >100 individuals per species, are significantly more associated with one or more of eight topographic habitat categories than in others. These results suggest that ecological ranges and dispersion of tree species in SW Sri Lanka is primarily mediated by soil water and nutrient levels in topographically different catenal habitats.
Discussion/Conclusion: The tree species in the Sinharaja FDP and the other sites studied show habitat-specialization even within small hill forests (< 1,000 m elevation). Many of them being threatened relict endemics, their distribution patterns have important conservation implications while these features are also useful criteria in site-species matching in forest restoration efforts.

O35-06 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
Wednesday 22 June / 16:00-17:30 – Einstein

Are montane shola forest trees ecologically distinctive among Western Ghats tree flora?

PRIYA DAVIDAR[1], DHARMALINGAM MOHANDASS[2]
[1]Pondicherry University, Ecology and Environmental Sciences, 605014, Pondicherry, India
[2]Xishuangbanna Tropical Botanical Garden (XTBG), Chinese Academy of Sciences, 666303, Menglun town, P. R. China

We assessed the local densities, range sizes, flowering patterns and reproductive traits of 62 species of evergreen trees (>= 1 cm dbh) in upper montane shola forests of the Nilgiri mountains, Western Ghats of India. The objective of the study was to see whether the tree flora was unique to montane regions, or was a subset of lower elevation flora of Western Ghats rain forests. Montane shola forests had significantly fewer endemic trees (6%) compared with Western Ghats rain forests (57%). The majority (71%) had broad latitudinal and elevational ranges. Fewer species were exclusively restricted to higher elevations (17, 27%), among which 6 were edge species with affinities to Indo-Malesia and South China. Sixty six percent were habitat generalists, and 58% occurred differentially on slopes with lesser gradients. Prevalence of dioecy was significantly lower (18%) than Western Ghats trees (37%). Among hermaphrodites examined, 17 species (53%) were self-compatible. Self-incompatible hermaphrodites and dioecious species occurred at significantly higher stem densities, and had higher levels of pollinator limitation, indicating that the tendency to outcross imposes a reproductive constraint. Bees were the main visitors to 42% of trees compared with 18% in medium elevation forest. Our analysis suggests that the montane flora consists predominantly of wide ranging tropical evergreen trees able to survive at higher elevations under climatic and reproductive constraints.

O36-01 – S36 *Free session: Biodiversity and palm oil plantations*
Wednesday 22 June / 08:30-09:30 – Sully1

Effects of Riparian Buffers on Stream Litter decomposition in Oil Palm Plantations in Borneo.

DARSHANAA CHELLAIAH, CATHERINE YULE, HOLLY BARCLAY
Monash University Malaysia, School of Science, 47500, Subang Jaya, Malaysia

Southeast Asia is undergoing extensive conversion of natural forests into exotic monoculture plantations, particularly oil palm (Elaeis guineensis). Headwater streams are heavily dependent on inputs of riparian leaf litter to provide energy and nutrients to aquatic food webs. Therefore, changes in riparian land use alters leaf litter inputs affecting aquatic productivity. Riparian buffer zones along stream and river banks are widely advocated as an environmental management tool to mitigate the impacts of land use activities on aquatic ecosystems but there is currently little evidence from tropical regions about the effectiveness of riparian buffer zones for conserving freshwater biodiversity and ecosystem function in monoculture plantation streams. This study was carried out in Sabah, Borneo, during Nov 2015 – Feb 2016. Streams (3-5m width) with different types of riparian vegetation were selected for this study (3 streams per vegetation type): (i) oil palm –planted to stream edge; (ii) oil palm planted to stream edge with no chemical application within ~20m of stream edge on both banks; (iii) oil palm with ~20m buffer of native vegetation along both banks; (iv) forested reference sites (upstream catchment including stream banks are covered by native forest. We compared the rates of leaf litter decomposition by microbes only and microbes plus invertebrates using litter bags containing 3g±0.001g leaf litter from oil palm and a native tree species, Macaranga tanarius incubated for 7, 14 and 30 days in each stream type. In general, Macaranga leaves decomposed faster with decay rate coefficients (k) ranging from k = 0.073 - 0.098, than oil palm leaves, ranging k=0.012 – 0.020 in all forest types. With regards to forest type, decay rates were affected by different riparian vegetation, generally being highest in oil palm plantation with a riparian buffer dominated by native vegetation. These results suggest that riparian vegetation affects leaf litter decomposition – a key ecological process in tropical streams – and that management practices which retain native vegetation along stream banks can help to protect the productivity of plantation streams.

O36-02 – S36 *Free session: Biodiversity and palm oil plantations*
Wednesday 22 June / 08:30-09:30 – Sully1

For decades of forest loss and degradation by expanding oil palm plantations and fires

DAVID GAVEAU
Center for International Forestry Research, Environment, 16000, Bogor, Indonesia

Plantations can replace natural forests or spare them by using lands already cleared for other reasons. We investigate the degree to which industrial oil-palm plantations are implicated in deforestation in Borneo. The forests of Borneo have also been impacted by El-NINO-induced fire at unprecedented scales over the last four decades. There is no island-wide documentation of forest loss from fire and conversion to plantations since the 1970s. Building on a detailed, LANDSAT-based, spatial inventory of forest cover, clearance and logging over the 1973-2013 period, the era of mega fires and industrial-scale forest exploitation on the island, we address the following questions: (i) How much forest cover has become degraded since 1970s; (iii) how much has been directly converted to Industrial Oil palm plantations, and use the time-delay between forest clearance and planting to infer likely causation between fire, deforestation and the establishment of plantations.
We demonstrate that the oil-palm industry has been the principle driver of species-rich old-growth forest loss in Malaysian Borneo, as 54–56% of all deforestation was associated with rapid conversion (within five years of forest clearance) to industrial oil-palm plantations. This figure is only 11–12% in Indonesian Borneo because: i) a much higher proportion of plantations were developed on lands cleared long before establishment; and ii) most deforestation in Indonesian Borneo occurred before the year 2000 despite the relatively minor oil-palm developments at that time. Drought and fire damaged several million hectares of forest during the 1983, 1991, 1994, 1997–98, 2002, and 2006 El Niño Southern Oscillation (ENSO) weather phenomena, mainly in Indonesian Borneo and to a lesser extent in Sabah, while Sarawak and Brunei were the least affected because of high, year-round rainfall. We estimate that 35% (6.5 million ha) of Borneo's forested area in 1973 was destroyed by large uncontrolled ENSO-drive fires during the last four decades. Unlike selectively logged forests, forests impacted by drought and fire tend to recover slowly. They become vulnerable to further burning and conversion to short vegetation follows. Therefore, burned areas or drought scars often become detected as "deforested" or "cleared" in satellite assessments of forest cover change20-22. We show here that these degraded lands together with other areas cleared before 1973 have sustained the recent expansion of plantations.

O36-03 – S36 *Free session: Biodiversity and palm oil plantations*
Wednesday 22 June / 08:30-09:30 – Sully1

Carcass removal by vertebrate scavengers in tropical Borneo: a case of ecological redundancy?

NORMAN LIM[1], DOUGLAS KELT[2], KELVIN LIM[3], HENRY BERNARD[4]
[1]Nanyang Technological University, National Institute of Education, 637616, Singapore, Singapore
[2]University of California, Davis, Wildlife, Fish, & Conservation Biology, 95616, Davis, U.S.A.
[3]National University of Singapore, Lee Kong Chian Natural History Museum, 117377, Singapore, Singapore
[4]Universiti Malaysia Sabah, Institute for Tropical Biology and Conservation, 88400, Kota Kinabalu, Malaysia

Background: A significant proportion of animals die from causes other than predation, and their carcasses are available to scavengers to whom they represent a high quality resource. Despite being a common and integral component of food webs, scavenging has largely been ignored by community ecologists, particularly in the tropics. Consequently, the identities and roles of scavengers are not well understood in many systems, and a crucial but understudied ecosystem service provided by scavengers is carcass removal. The potential importance of carcass removal was exemplified recently in India, where the scavenging vulture (Gyps spp.) guild collapsed due to the use of anti-inflammatory drug diclofenac in cattles; this led to an increase in feral dog and rat populations, resulting in concerns about increased risk of spreading diseases like rabies and anthrax to humans.
Methods: Here, we examined the relative importance of taxonomic groups in removing carcass in tropical habitats in Borneo via exclusion experiments. We also recorded the change in carcass mass over time, and investigated the impact of diversity effects (i.e., species richness and functional diversity) and land use changes (primarily selective logging and oil palm plantation conversion) on carcass removal.
Results: Vertebrates dominated carcass consumption and did so more rapidly than macroinvertebrates, which in turn were more efficient and rapid than microinvertebrates and microbes. Carcasses left on the forest floor (e.g., not excluded from vertebrates) were completely consumed in an average of 4.2 days.
Conclusion: Contrary to our prediction, carcass removal by vertebrates was not influenced by species richness, functional diversity, or land use changes; we discuss the findings in relation to identities and occurrence of scavengers in the landscape and ecological redundancy. We also documented high variability in the duration of carcasses remaining on-site, reflecting the opportunistic nature of facultative scavenging in our system.

O36-04 – S36 *Free session: Biodiversity and palm oil plantations*
Wednesday 22 June / 08:30-09:30 – Sully1

Rehabilitation of Mangrove Ecosystem in Sabah, Malaysian Borneo

SHIN WATANABE
University of the Ryukyus, Tropical Biosphere Research Center, 907-1541, Taketomi, Japan

Mangrove tree species are salt-tolerant evergreens that grow along coastlines, rivers and deltas. The mangrove forests of Southeast Asia are highly biodiverse and provide multiple ecosystem services upon which millions of people depend. A recent study has suggested that mangrove forests in Southeast Asia were lost at an average rate of 0.18% per year between 2000 and 2012 (Richards 2016, PNAS). Though the main pressure was different in each country, aquaculture, rice agriculture and oil palm plantation are major drivers of mangrove loss. In the case of Sabah, Malaysian Borneo, illegal oil palm plantations have often encroached preserved mangrove forests and Sabah Forestry Department has been making effort to reforest mangroves in devastated lands (Sabah Forestry Department 2013, Ann. Rep.). However, it is very difficult to select suitable mangrove tree species after the original configuration of the land is completely changed. In addition, It is also significant point whether a rehabilitated mangrove forest can have a high biodiversity as same as the forest had before devastated. Therefore, in this research, to confirm a suitable ecological niche of each primary mangrove species, we measured growth of several mangrove species replanted in different ground level in a 2 ha rehabilitated site. As the result, it was found each mangrove tree species showed different tree growth in the different ground level. In addition, to check the initial state of biodiversity of the site, we carried out a biodiversity survey for insect, fish, crustacea and plant. We plan further monitoring research in the same place 3 years later and will compare the change of the biodiversity with the change of replanted mangrove forest.

O37-01 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

Honeybees and honey gatherers: Co-sentinels of climate change in the Congo Basin

DOUNIAS EDMOND
IRD-CIFOR, UMR5175 CEFE, 34293, Montpellier cedex 5, France

Background: The proposed communication is based on the assumption that the Central African forest dwellers could play a growing role as 'sentinels' of the Congo Basin forests, by assisting the scientific community in better documenting the effects of climate change.
Methods: Our presentation will focus on the biotemporal signals that are detected by indigenous peoples from their surrounding forest environment. This perception conditions the local capacity to anticipate seasonal fluctuations and is a determining step in decision-making. Insects provide a particularly accurate category of signals because they are sensitive to very subtle fluctuations of climatic conditions, at tight thresholds that are not directly perceptible by humans. Among insects, bees have developed the highest sensitivity to tiny modifications of their environment. The function that bees can play as sentinels that alert us about subtle landscape alterations, no longer needs to be demonstrated.
Results: We will introduce the 'Sentimiel initiative', a citizen science program guided by with the twin aims of i) constructing a network of cooperative initiatives at the international level and ii) ensuring, through this network, the monitoring of effects of climate change, viewed through the prism of their impact on bees and on their production of honey and associated products. The fundamental challenge of the Sentimiel initiative is to valorize traditional ecological knowledge regarding beekeeping and honey collecting through a network that federates diverse local actors who possess empirical knowledge about bees and their productions and who, by their regular observation of the activity of these social insects, can monitor the impact of climate change on local biodiversity. Analysis of the information delivered by bees has focused on the domestic honeybee in the context of professional or semi-professional beekeeping. By contrast, knowledge based on subsistence honey collecting, which addresses an incredible diversity of honey-producing bees, has so far been ignored.
Conclusion: Citizen science initiatives offer new ground for partnership between indigenous and academic sciences with the joint objective to better understand the effects of climate change on Congo Basin rainforests, and to elaborate appropriate community-based adaptive responses.

O37-02 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

From elephants to ants: changes to ant assemblages caused by the impact of elephants in an African biodiversity hotspot

HEATHER CAMPBELL[1], CATHERINE PARR[2], BERNDT VAN RENSBURG[3], MARK ROBERTSON[1]
[1]University of Pretoria, Zoology and Entomology, 0083, Pretoria, South Africa
[2]University of Liverpool, Earth, Ocean and Ecological Sciences, L69 3GP, Liverpool, United Kingdom
[3]University of Queensland, Biological Sciences, 4072, Brisbane, Australia

Background: Maputaland sand forest is a unique but highly threatened habitat within the Maputaland-Pondoland-Albany biodiversity hotspot in southern Africa. Maputaland sand forest is characterised by high levels of plant and animal endemism. In South Africa, anthropogenic impacts have reduced sand forest to diminishingly small patches, often inside reserves. Within protected areas additional threats exist to sand forest. In Maputaland, high elephant densities have led to increased feeding on sand forest, rather than savanna, plant species. Elephant herbivory dramatically alters vegetation structure from complex, closed sand forest to an open savanna-like structure. This negatively impacts biodiversity through changes in animal assemblage composition, an effect observed for dung beetles, birds and spiders.
Methods: Ants are the dominant invertebrates in tropical forests but the impacts of elephant-induced changes on sand forest ant assemblages are unknown. We conducted the first comprehensive survey of ant diversity in Maputaland. Our sampling examined ant assemblages in sand forest patches with different levels of elephant herbivory, as well as in adjacent areas of savanna.
Results: Sand forest and savanna contain distinct ant assemblages and we report many new species records for Maputaland. Most importantly we show that ant assemblage structure varies in sand forest with different levels of elephant-induced habitat modification. Some ant species, especially those with specialised nesting and feeding behaviour, are present only in patches of sand forest with minimal levels of elephant herbivory. The absence of specialist ant species in highly-impacted sand forest is of great concern for preservation of ecosystem function. Savanna and elephant-impacted sand forest were occupied by generalist and open habitat ant species.
Discussion: The implications of these findings on sand forest conservation are not limited to ant biodiversity in Maputaland. Ants respond quickly to environmental change and are essential to ecosystem function. Their involvement in many ecological processes means they can be used as bioindicators to study the impact of herbivores on tropical forests. The loss of invertebrate species with important functional roles, as a consequence of larger, charismatic megafauna, presents a challenge to conservation and management of protected areas in biodiverse African forests.

O37-03 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

The role of large animals in distributing sodium through African forests

DOUGHTY CHRIS
Oxford, Geography, OX1 3QY, Oxford

Sodium, an element which is needed by animals but often toxic in high concentrations to plants, may be deficient and limit animal abundance in inland continental regions, but may be overabundant and limit plant productivity in coastal regions. I present data from 50 independent plots (including leaf data from more than 2,480 individual trees) showing that leaves uptake high amounts of sodium (Na) in a manner more similar to the essential cation potassium (K) than to the toxic cation aluminium (Al). Total Na concentrations are ~10 times higher in coastal regions than inland regions. I also present data testing whether large animals like forest elephants and hippos that are abundant Southern Gabon play a large role in reducing such Sodium concentration gradients by transporting it inland. I compare these data to a diffusion model and a Na loss rate based on empirical data to test whether large animals may have moved significant quantities of Na inland away from coastal regions in Gabon and how this affects ecosystem properties such as decomposition rates.

O37-04 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

Uneven spatial density distribution of African pouched rats (Cricetomys spp) in a West African montane forest landscape

BIPLANG YADOK[1], HAZEL CHAPMAN[1], PIERRE-MICHEL FORGET[2], DANIEL GERHARD[3]
[1]University of Canterbury, School of Biological Sciences, 8041, Christchurch, New Zealand
[2]National Museum of Natural History, Department of Ecology and Biodiversity Management 1 av. du Petit Château, F-91800, Brunoy, France
[3]University of Canterbury, Mathematics and Statistics, 8041, Christchurch, New Zealand

Recently the African giant pouched rat (Cricetomys spp) has demonstrated the potential to disperse seeds in African forests yet very little is known about its behaviour in forest habitats. To determine the distribution of Cricetomys sp. in Ngel Nyaki forest Nigeria, we investigated i) the density ii) population size iii) home ranges and iv) factors that determine habitat choice. We used a capture-mark-recapture survey in a Spatially Explicit Capture Recapture (SECR) framework. Caged traps arranged in 8x8 grids were set in one grassland and two forest locations, each having an overall trapping area of ~4.5ha. While our scarce data on the grassland were not analysable, we found that there was a significant variation in densities of rats between the two forested sites which were identified as forest-site-1 and forest-site-2. The estimated rat density and population size in forest-site-2 were four rats/ha and 41 rats respectively; these values were two times higher than the values estimated for forest-site-1. The estimated home ranges (σ) of the rats were however similar in both sites ~20m. Our logistic regression test for environmental factors affecting habitat choice showed that all the measured habitat variables at each trap location were not significant. Overall, our study suggests that tree species composition rather than similarity in habitat characteristics may have more effect on the distribution of Cricetomys as has been observed with the Neotropical acouchy, a rodent similar in size and scatter hoarding behaviour.

O37-05 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

Promoting Indigenous Vegetables for Biodiversity Conservation and Sustainable Livelihoods Improvement in Rwanda

DANCILLA MUKAKAMARI[1], PLACIDE RUKUNDO[2], NATHAN KANUMA TAREMWA[3]
[1]Association of Rwandan Ecologists, National Coordination/AWARD, 3967, Kigali, Rwanda
[2]Rwanda Agriculture Board (RAB, Department of Horticulture, 5016, Kigali, Rwanda
[3]University of Rwanda, College of Agriculture, Animal Sciences and Veterinary Medicine (CAVM, 3971, Kigali, Rwanda

Indigenous vegetables (IVs) are highly valuable in most African communities. IVs are considered to be highly nutritive, resilient to climate change and require less work compared to exotic varieties such cabbage and tomato. They contribute on food security and income generation but also play an important role in health, social and culture. Despite their values, these vegetables have not been promoted by policy makers and fewer researchers have showcased their importance in Rwandan economy. This paper therefore focuses on how IVs would contribute towards sustainable livelihoods improvement without compromising biodiversity conservation in Rwanda. Specifically, the study has the following objectives: (i) to analyze farmer's perception towards production and utilization of IVs (ii) to establish the list and conservation status of most important IVs (iii) to assess challenges and prospects to improve IVs production, acceptability and consumption. This study was conducted in three sectors adjacent to Cyamudongo forest in Rusizi District, Western Province of Rwanda. The sample included 140 rural farmers including men, women and youth. Snowball and purposive sampling techniques were used to identify IVs producers. The methodology and approaches in this study included documentary review and primary data collection through individual face to face interviews and focus group discussions (FGDs). The study revealed that forty five percent (45%) of respondents grow and consume IVs. They perceive IVs as highly nutritive, easy to grow and prepare for home consumption, essential for health improvement as traditional medicinal plants and do not require chemical inputs. The common indigenous vegetables found include: Amaranthus (72%), Nightshade (12%), Spider plant (5%), Turkey Berry (2%). The local communities strongly appreciated the value of IVs but raised their concerns regarding lack of extension program. Consumption is only at the subsistence level and scarcely available for market. Except Amaranthus, all other IVs highlighted grow naturally around the homestead and this limits the amount available for consumption. Domestication of IVs would avoid their extinction and enhance usability and market assurance. Special attention is therefore needed from researchers, policy makers and extension services for sustainable production and consumption of these neglected crops.

O37-06 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

The abundant and the widespread – how do functional traits of dominant and broad-range species compare to overall trait space in trees, other terrestrial plants, and epiphytes?

DAVID SCHELLENBERGER COSTA, GERHARD ZOTZ, MICHAEL KLEYER
University of Oldenburg, Environmental Sciences, 26111, Oldenburg, Germany

Background: Co-occurring species within ecosystems often show a wide range of trait expressions. These trait expressions allow for survival in specific habitats, but species differ in both their abundances and the range of environmental conditions they tolerate. This may be a result of particular trait values or large intraspecific variability compared to the respective communities.
Methods: Leaf and stem samples were collected for all vascular species accounting for 80 % of the terrestrial plant biomass in 60 plots of 50 x 50 m along an elevation gradient of 3500 m at Mount Kilimanjaro, Tanzania. Low-level vascular epiphytes were sampled from the ground on the same plots. One major tree per plot was climbed and all epiphyte species collected. Another tree was selected and one outer branch retrieved to record outer-canopy epiphytes. Abundance was estimated for both terrestrial and epiphytic vascular plants. Plant functional traits including leaf C, N, and P content were measured for all samples obtained.
Results: Broad-range species were characterized by low specific leaf area, low leaf P content in terrestrial plants, and large intraspecific variability in most traits investigated. Dominant species also had low specific leaf area and trait values relatively centered in the overall trait ranges. While dominant epiphytes overlapped strongly in the traits investigated, this was not the case for terrestrial plants, both trees and others.
Discussion: Our findings indicate that the size of species distributions is mainly determined by the plasticity of functional traits within species, rather than by absolute trait values. In contrast, dominant species are characterized by trait values close to the community mean. These trait values may offer highest revenue for growth investment and other species may clump around those being constrained by limiting similarity. In addition, both dominant and broad-range species responded to a probable P-limitation of their habitats: Low leaf P content may be an adaptation to the scarcity of this resource at Mount Kilimanjaro. In general, competition appeared to be stronger among terrestrial plants than among epiphytes, as the dominant epiphytes showed significant trait overlap, while terrestrial plants separated clearly in terms of most traits.

O37-07 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

Rare tree species support functional diversity in resource-acquisition in central African forests

ELIZABETH KEARSLEY[1], KOEN HUFKENS[2], HANS VERBEECK[1], MARIJN BAUTERS[3], HANS BEECKMAN[4], PASCAL BOECKX[3], DRIES HUYGENS[3]
[1]Ghent University, Department of Applied Ecology and Environmental Biology, 9000, Gent, Belgium
[2]Harvard University, Department of Organismic and Evolutionary Biology, 02138, Cambridge, USA
[3]Ghent University, Department of Applied Analytical and Physical Chemistry, 9000, Gent, Belgium
[4]Royal Museum for Central Africa, Laboratory for Wood Biology and Xylarium, 3080, Tervuren, Belgium

Tropical forests are characterized by a high biodiversity. The dominance structure of ecological communities shows that the species present are nevertheless not evenly distributed, and a large number of species have a low abundance. In the context of identifying processes underlying the maintenance of species diversity and species co-existence, we examine the relationship between the rarity of tree species and their contribution to functional diversity at a central location in the tropical rainforest of the Congo Basin. in both old-growth mixed and monodominant forest of Gilbertiodendron dewevrei.
Functional diversity indices are assessed using a set of functional traits representing unique contributions to plant resource capture and growth, namely wood density, specific leaf area, leaf nitrogen content and leaf stable carbon isotope composition. In both forest types, tree species covering a cumulative 95% basal area in five one-hectare plots are included in the analysis, with a total of 738 individual trees being sampled, covering 105 species. For each species, the contribution to functional diversity is determined by assessing the extremity of species trait locations within the functional trait space and by quantifying the distance between functional characteristics of different species or functional distinctiveness. The relationship between these measures and the rarity of the species in the tree communities are determined.
Our main finding is that within mixed and mono-dominant forest ecosystem, rare species support the trait combinations with the highest functional distinctiveness. Rare species however cover the entire range of low and high functional distinctiveness, contributing both unique and redundant functions. Common species only show a low contribution to functional diversity but are crucial for aboveground carbon storage. We argue that within carbon sequestration initiatives, inclusion of both functional diversity and biodiversity conservation is imperative not only for conservation purposes but also to sustain the stability of the ecosystem.

O37-08 – S37 *Free session: Tropical ecology and society in African ecosystems*
Wednesday 22 June / 10:00-12:00 – Sully1

The critical status of protected areas in Africa

SANDRA TRANQUILLI
Aarhus University, Centre for Biocultural History, 8000 Aarhus C, Aarhus, Denmark

In the last decades increased human population growth and its associated activities have caused an alarming decline in wildlife populations and contributed to the degradation of many forests in tropical Africa. This has led to the creation of numerous protected areas (PAs) to protect their natural resources. However, despite their protected status, PAs face significant threats from human activities, and conservation efforts are still minimal in several areas. This study evaluates specific anthropogenic disturbances and their impact levels to wildlife in PAs both at a continental and regional scale, and analyses which conservation actions are best suited to reduce threat impact levels. The study focused on 98 PAs across West, Central and East Africa characterized by significant wildlife populations. A list was generated on direct threats, with short-term and immediate effects on wildlife populations, and indirect threats, with long-term effects that drive wildlife population declines, and a score of their impact level (i.e. absent, minimal, not critical, critical to wildlife survival) was completed for each PA. Data on conservation activities belonging to three categories (law enforcement, tourism and research) was collected for each PA. Information was assembled from questionnaires, published and unpublished studies of the past twenty years. The percentage of PAs having a particular threat at different impact levels was calculated to reveal any differences at a continental and regional level. General Linear Models (GLMs) were constructed to evaluate the relative importance of specific conservation activities variables in relation to the threat impact level. The results show that 89% of African tropical PAs are under high pressure from anthropogenic threats. Subsistence and commercial hunting are identified as the most common direct threats for 56% of all PAs and to be most prevalent in West and Central Africa. Agriculture and logging are identified as the most common indirect threats (48% and 45% respectively) and the most prevalent in West Africa. GLMs reveal that the long-term presence of law enforcement guards, active research and tourist stations are associated with lower threat impact level. The study supports existing evidence that the majority of African PAs in tropical Africa are in a critical state and suggests policy makers, funding bodies and conservationists how to best invest into conservation activities.

O38-01 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Developing and implementing a human wellbeing framework for conservation planning

KELLY BIEDENWEG
Oregon State University, Fisheries and Wildlife, 97331, Corvallis, USA

Background: Across scientific fields, there have been calls to improve the integration of scientific knowledge into policymaking. Particularly since the publication of the Millennium Ecosystem Assessment, these calls increasingly refer to data on human wellbeing related to the natural environment. Yet policy decisions involve selective uptake of information across inherently different communities with different values and processes. Additionally, researchers face the fact that there are important tradeoffs in producing knowledge that is simultaneously credible, legitimate and socially relevant.
Method: This paper presents a study that developed human wellbeing indicators for Washington State's ecosystem recovery agency. Over two years, we engaged stakeholders, policymakers, and social scientists in the identification, modification, and prioritization of wellbeing indicators that were adopted by the agency for biennual monitoring and strategic planning. We conducted 61 interviews with diverse stakeholders, reviewed 91 documents associated community values and priorities, and held 8 workshops where an additional 86 stakeholders modified and prioritized indicators based on their local relevance and importance. This resulted in 26 indicators that were then rated by 8 social scientists for theoretical soundness, sensitivity to environmental changes, and cost effectiveness, among other criteria. Concurrently, 13 policymakers reviewed the indicators for their relevance to management concerns, understandability to public and policymakers, and ability to link measurable reference points and targets.
Results: The project developed and validated a general framework for HWB indicators that includes Social, Cultural, Psychological, Physical, Economic, and Governance domains. We identified 15 indicators that were broadly accepted and important to all audiences. Policymakers preferred indicators across all domains, essentially mirroring stakeholder input. Social scientists, however, were more divergent in their ratings.
Conclusion: Although the scientists, policymakers and stakeholders used different criteria to identify and prioritize indicators, they all agreed that indicators associated with each of the six domains were critical to assess the holistic concept of wellbeing related to ecosystem restoration. We present the research findings, the final adopted indicators, and how the indicators are being used within the state ecosystem recovery agency.

O38-02 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Measuring biocultural interactions and dynamics for sustainable resource management

ELEANOR STERLING[1], SOPHIE CAILLON[2], CHRIS FILARDI[1]
[1]American Museum of Natural History, Center for Biodiversity and Conservation, 10024, New York, USA
[2]CNRS, Center for Functional and Evolutionary Ecology, Montpellier, France

Background: Measuring progress toward sustainable resource management goals is important and challenging. However, indicators of success or wellbeing developed at regional or global scales can mischaracterize local values, discount local worldviews or knowledge, and can exclude local actors from regional and global dialogues. By considering cultural and ecological dimensions of a given place-based setting as interwoven feedbacks, biocultural approaches result in indicators that support more inclusive conservation planning at the local level and that resonate at a regional or global scale. However, it is not clear to what extent the current measurements balance attention to the biological and cultural elements of a system and how to best characterize feedbacks between these elements.
Methods: We present results from the literature on biocultural approaches to sustainable resource management.
Results: Biodiversity conservation efforts within Social-Ecological Systems frameworks often focus on the sociocultural and economic elements of a biocultural system, for instance the importance of ecosystem services to humans. This counters previous conservation strategies that only considered the biological elements and neglected important human-mediated drivers of system dynamics. However, perhaps the pendulum has swung too far away from important ecological dynamics and valued feedbacks between humans and their environment. Within biocultural frameworks, humans, animals, ancestors, spirits and places form a system with feedback interactions. Human wellbeing is not possible without ecological health. Yet most indicators measure sociocultural, economic, or biological elements separately; few effectively capture feedbacks or interactions specifically.
Conclusion: To develop indicators meaningful for both local and international stakeholders, we need to adopt a biocultural approach that will include local actors from the outset. Only then can we focus on interactions rather than on objects of conservation and overcome the divide between people and ecosystems so prevalent in our Western societies. Key short- and long-term ecological dynamics need to inform decision-making as do overlaps and disconnects between human perceptions and ecological realities. More work needs to be done to portray and manage feedbacks between sociocultural, economic and biological aspects of a biocultural system to contribute most effectively to their sustainable management.

O38-03 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Community forestry projects and the strengthening of capabilities and agency in the Oxapampa-Ashaninka-Yanesha Biosphere Reserve, Peru

CLAUDIA BOURONCLE[1], ALEJANDRA BONI[2], JORDI PERIS[2]
[1]Tropical Agricultural Research and Higher Education Centre (CATIE), Climate Change and Watersheds Program, 30501, Turrialba, Costa Rica
[2]Universidad Politécnica de Valencia (UPV), Department of Engineering Projects, 46022, Valencia, Spain

Assessment of community forest management (CFM) has generally been limited to conservation and production dimensions and social aspects have been neglected. We applied the capability approach to analyse a community forestry project in the Amazonian Oxapampa-Asháninka-Yánesha Biosphere Reserve, developed over >10 years by Peruvian NGOs, local associations and artisans of three indigenous communities. This vital biosphere reserve covers >18.000 km² and is inhabited by native Americans and colonos whose livelihoods depend on agriculture and natural resources. We studied the entire forest production chain, including the participatory development of CFM plans, in an environment with considerable logistical and financial obstacles to CFM. As NGOs had considered many technical aspects of CFM, we sought to identify the social elements that had contributed to the continuity of the project.
Working with community actors, we asked what were the dimensions of their welfare and how CFM contributed to those dimensions, as well as to improvements in their ability to help themselves and those around them. We used qualitative research tools and identified possible gender inequalities in access to benefits.
Participants identified nine dimensions of their welfare (capabilities) and women and men prioritized different sets, though gender was not a factor contributing to exclusion. All participants had expanded access to these capabilities thanks to cash income, greater availability of time, acquisition of knowledge and self-esteem. People recognized an increase in self-confidence and power to bring about change, and several of them joined initiatives to manage improvements in their communities after experience in the project. Group feed-back, recognition of their work and income were important factors for those changes.
The capabilities identified ranged from personal to territorial scales and are consistent with local ethical values; women assign greater importance to personal and family areas than men, but men have a wider range of preferences that includes social recognition. The project helped both groups to develop functioning related to capabilities they most value in a difficult environment; it also supported agency development of project partners as individuals. However, there is still no evidence that CFM is contributing agency of an organized group. The consolidation of this project requires organized, not individual, community participation.

O38-04 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Does community-based forest management improve wellbeing in Tanzania?

NICOLE GROSS-CAMP[1], LASIMA NZAO[2]
[1]UCL, Anthropology, WC1H 0BW, London, UK
[2]UCL, Anthropology, 0206, Arusha, TZ

We examine the influence of forest decentralization in Tanzania on human wellbeing. Using a quasi-experimental design, we explore differences in villages with and without community-based forest management (CBFM) before and after CBFM establishment in two districts. Four villages with CBFM were selected and matched to sites without CBFM using socio-demographic characteristics. The study employed two methodologies: (1) a participatory video process (PV) to establish a locally-grounded definition of wellbeing, and (2) a questionnaire, developed from the themes arising from the PV, and facilitating an empirical exploration of wellbeing aspects as they were in 2005, when CBFM was established in the villages, and 2015. PV was done in four villages (2 with and without CBFM). Wellbeing questionnaires were done in all eight villages (N=320) stratified by gender, wealth rank and leadership status. Wealth rank was relative to a village and assigned to each household by a group of community representatives following an agreement of wealth category definitions. Wellbeing themes arising in the PV films were supportive of prior research emphasis on material aspects of wellbeing and similar in areas with and without CBFM. The larger PV process provided further insights into the importance of relational (social and political processes) and subjective (individual, social and cultural norms) aspects of wellbeing. For example, three of the villages described a shift away from traditional cultural practices conducted in the forest to appease ancestors or bring rain, to dominant religious practices. Results from the questionnaire revealed subtle differences in the wellbeing of people in areas with and without CBFM, and an indication that areas with CBFM are experiencing slightly greater constraints on land and food security but have better water access. These findings suggest that (1) CBFM has limited value in improving people's wellbeing (and may even reduce it) or (2) that our characterization of wellbeing is inadequate and fails to capture relevant characteristics. If the former is true it begs the question, why does CBFM persist in the absence of social benefit? In contrast, people largely state that they are supportive of CBFM presence, know the leaders involved in its management, and feel able to exert influence on its management through these leaders. These sentiments imply value of the CBFM by communities and exemplify the challenges of identifying wellbeing indicators.

O38-05 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Linking wellbeing with cultural-identity building for greater cognitive justice in conservation: lessons from Venezuela in Canaima National Park

IOKIÑE RODRIGUEZ
University of East Anglia, School of International Development, NR4 7TJ, Norwich, United Kingdom

Conservation policies across the globe have often suppressed non-scientific forms of knowledge and ways of knowing nature, along with social practices of groups that are informed by such knowledge. Apart from the impact that this has had on local peoples' livelihoods and identities, the exclusion of local knowledge from conservation practice has often resulted in inadequate environmental policies. Reversing this process of epistemic supremacy is crucial both for achieving greater cognitive justice in conservation areas but also for ensuring that conservation aims are achieved. Doing so however is not easy task. In situations of oppression, hidden environmental knowledge is not easily made visible unless adequate conditions for it to emerge are created.
I argue that one way forward is by conservation engaging with the well being agendas of indigenous people, in particular with the construction of their life plans. A "life plan" is a plan made by indigenous people in an effort to maintain traditions, customs, and the hope of having a society with its own identity based on the traditional knowledge of its people. The development of life plans offers a unique opportunity for a dialogue of knowledge between socio-ecological scientists and indigenous peoples over contentious environmental issues.
I illustrated this discussion with by a case study in Canaima National Park, Venezuela, where over the last twenty years socio-ecological research has sought to understand existing conflicts over the use of fire while supporting the development of Pemon Life Plans – the indigenous peoples in this area. Assisting in the development of Life Plans through participatory historical reconstructions, territorial self-demarcation processes, and facilitating community reflexivity about its socio-ecological changes and desired future has been decisive for the Pemon revealing fire management knowledge that challenges conventional explanations of landscape change. This local knowledge, combined with results from studies of Pemon fire regimes, fire behavior ecology and paleo-ecological research, now inform a counter narrative of landscape change that is influencing a shift in environmental discourse and policy making towards an intercultural fire management approach.
The Canaima case study demonstrates that if we are looking at linking well being and conservation agendas with a view of achieving greater justice, cultural identity-building must be part of the equation.

O38-06 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Wellbeing and conservation: Can humans and forests thrive together?

PAULA TALLMAN, ALAKA WALI, DIANA ALVIRA, ASHWIN RAVIKUMAR, MIGUEL MACEDO
[1]The Field Museum of Natural History, Integrated Research Center, 60605, Chicago, US
[2]The Field Museum of Natural History, Science Action Center, 60605, Chicago, US

Background: In this presentation, we will discuss our findings from a nine year project in the Northern Peruvian Amazon using an assets-based approach to conservation and wellbeing that engaged communities in protected areas in participatory management of their lands and natural resources. The theoretical base for an assets-based approach posits that Amazonian peoples (indigenous and traditional forest-dwellers) have retained and constructed cultural practices drawing on heritage and deep ecological knowledge that are compatible with the sustainable use and conservation of forest environments. These practices, however, are often dismissed or actively suppressed by National society and at times Conservation organizations.
Methods: We developed the methodological framework for an assets-based approach to conservation and well-being that privileges the cultural values and resources management strategies of local people and empowers them to implement their own priorities for improving livelihood. We did this by working with communities to produce and implement quality of life plans that are customized to build upon their unique strengths.
Results: We have observed that these assets-based quality of life plans that can act as a road-map for pragmatic action that community members can undertake, shifting the balance of power from the external agents of government and civil society to the community itself. This assets-based approach is sensitive to gender and generational social dynamics, recognizing that internal community dynamics are also sources of inequality. We will discuss the details of our approach, the quality of life plans that have resulted, and the barriers and challenges that we have encountered throughout this process.
Conclusions: Our work and participatory research demonstrates that in fact, local cultural practices and systems of knowledge streams can be the foundation of livelihood strategies that allow human communities and the forests to thrive together.

O38-07 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Conservation units and territorial exclusion of traditional peoples: analyzing the social impacts of environmental compensation strategies in Brazil

ANAYA FELISA FELISA ANAYA[1], MÁRIO SANTO[2]
[1]Unimontes, Saúde Mental e Coletiva, 39408128, Montes Claros, Brasil
[2]Unimontes, Biologia Geral, 39408128, Montes Claros, Brasil

Introduction: the creation of the conservation units (CUs) of integral protection (equivalent to IUCN category Ia) is a hegemonic strategy in the conservation biology and translate social and cultural values based on the idea of ecological sanctuaries to be preserved and managed without the impacts of human activities. However, this conservation strategy has caused the emergence and proliferation of environmental conflicts involving territorial rights of traditional peoples and local communities in many parts of the world. This study aims to analyze the impacts of the creation of a system of CUs of integral protection on the livelihoods and wellbeing of traditional peoples (first nations and slave descendants) and local communities of the north of Minas Gerais state, in Brazil.
Methods: we analyzed the environmental conflicts emerging in the study region from the perspective of the Political Ecology and the Critical Sociology. For this purpose, we obtained documents from Brazilian government institutions involved in environmental protection and regulation, and in the resolution of juridical disputes (the Federal and State Prosecutor's Office). We used the extended-case method, conducting fieldwork to observe and register the movements of social resistance of traditional peoples and local communities, and also conducting interviews with key stakeholders.
Results: during the 1990's, a large irrigation project was implemented at the margins of the São Francisco river in the north of Minas Gerais. To compensate to the huge environmental impact of the project, several CUs of integral protection were created, disregarding the traditional peoples that inhabited the region but did not have land titles. As a consequence, these populations were expelled from their territories without compensation or resettlement, with severe restriction to their traditional livelihoods, including access to natural resources such as water, fisheries and fruit collection. They initiated a social movement, empowered by the support of NGOs and civil associations, to negotiate their territorial rights and reclassify part of the CUs from integral protection to sustainable use.
Conclusion: this case study reveals the contradictions of the sustainable development ideology and the "economy of repair". Development strategies based on environmental compensation strategies are fated to failure if the historical, social and cultural contexts of the affected region are neglected.

O38-08 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Post-Sidr Scenario and Forest Conservation in the Sundarbans: Whose Knowledge Counts?

MD NADIRUZZAMAN
Exeter University, Geography, EX4 4RJ, Exeter, UK

This research investigates basis and process of the Bangladesh government's decisions in conjunction with post cyclone Sidr recovery and forest conservation. This argues that collective environmental decisions are often established on power-laden and politics-driven knowledge framework. Thus, such knowledge production could potentially marginalise and deprive the bottom strata of the power ladder. Though Bangladesh government's post-Sidr recovery plan was to engage affected community to remove damaged trees, they took an immediate U-turn on their earlier decision and defended their new decision on two grounds – i) if people were allowed into the forest they would cut down good trees along with the damaged one; and ii) uprooted plants and broken branches would decompose and, thereby, add nutrients to the forest's soil and so assist the rapid regeneration of the forest. This is an ethnographic research, which involves long-term lived experience with the affected community to understand their engagement with and knowledge of the forest, review of grey literatures to understand history of Sundarbans' management, interview with the key government officials, forest guards, forest scientists, environmentalists, conservation agencies, activists and other relevant people. It appears that the Sundarbans' has a contrasting and donor manoeuvred management history and post-Sidr decision was also the same. And, Sundarbans dependent people have hardly any participation in the production of forest conservation knowledge.

O38-09 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

Using local-level data to monitor REDD+ social safeguards: Evidence from 6 countries

AMY DUCHELLE[1], CLAUDIO DE SASSI[1], PAMELA JAGGER[2], ANNE LARSON[3], IDA AJU PRADNJA RESOSUDARMO[1], CHRISTY DESTA PRATAMA[1], MARINA CROMBERG[1], WILLIAM SUNDERLIN[1]
[1]CIFOR, Climate Change and Energy, 16115, Bogor, Indonesia
[2]University of North Carolina at Chapel Hill, Public Policy, 27599, Chapel Hill, USA
[3]CIFOR, Equity, Gender, Tenure, 15100, Lima, Peru

Background: The 2015 Paris climate agreement consolidated the reduction of emissions through avoided deforestation and forest degradation and enhancement of carbon stocks (REDD+) as a key strategy for mitigating global climate change. The REDD+ mechanism includes social safeguards that strive to protect and enhance local governance and wellbeing, ensure local participation and appropriate consent, and secure local rights to land and resources. While safeguards represent a key step for promoting social and environmental integrity in REDD+, the major challenge is in their operationalization and monitoring.
Methods: Through the Center for International Forestry Research (CIFOR) Global Comparative Study on REDD+, we evaluated social safeguard indicators at 22 subnational REDD+ initiative sites in Brazil, Peru, Cameroon, Tanzania, Indonesia and Vietnam. We carried out surveys in 150 villages and nearly 4,000 households (including control groups) in 2010-2012 (pre-intervention) and 2013-2014 (post-intervention) to assess local participation in REDD+ and evaluate the impacts of interventions on local livelihoods (e.g. tenure security, income, assets).
Results: We found a dominance of positive incentives applied at REDD+ sites, such as livelihood enhancements, in relation to other intervention types (e.g. punitive regulatory measures). There was significant improvement in household income and perceived wellbeing at the aggregate level, yet we found high variability between countries and study sites. While local knowledge of REDD+ initiatives increased over time, participation was still lacking, especially among women. There was limited attribution of changes in perceived tenure security and forest clearing to interventions on the ground.
Discussion: Our results reflect the persistent challenge of promoting full and effective participation of local people in conservation and development initiatives, with REDD+ being no different. They also highlight the challenge of linking local land tenure regularization to national-level processes for more effective tenure security outcomes. Finally, they underscore the need for ground-truthing REDD+ social impacts, particularly those related to local rights and participation, for which data may be limited in national and subnational surveys. Our findings will be useful to policy makers, practitioners and researchers interested in monitoring and supporting REDD+ safeguards in the post-2020 climate regime.

O38-10 – S38 *A brave new world: integrating wellbeing and justice in conservation*
Wednesday 22 June / 14:30-17:30 – Sully1

The psychology of human wellbeing as a predictor of long-term capacity for conservation

KAYLA A. CRANSTON
Antioch University New England, Environmental Studies Department, 03431, Keene, USA

Long-term capacity for conservation is often cited as a main goal of programs that aim to both conserve biodiversity and foster the wellbeing of humans involved in that conservation. One recurring challenge is evaluation—how do you know you have built capacity that will last long after external leaders and funding are gone? Intrinsic motivation has been empirically shown to correlate with human wellbeing and to predict long-term, durable action toward conservation goals. In this presentation, I discuss my research that aims to define and measure dimensions of intrinsic motivation such as empowerment, self-determination, and meaningful action in the context of biodiversity conservation. I review theoretical insight from the field of community and positive psychology to help supplement our current understanding of these concepts. Based on this investigation, I propose a psychological measurement for evaluating aspects of intrinsic motivation for biodiversity conservation in people responsible for the continuation of these regional efforts. I describe the results of research I've conducted with this instrument and discuss suggestions for its use to identify which capacity building strategies are most effective at fostering long-term, durable human well being and motivation for conservation. Together, this presentation explores the development and use of a psychology-based instrument that supports a novel approach to effectively fostering human wellbeing while sustaining action toward the goal of biodiversity conservation.

O39-01 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
Wednesday 22 June / 08:30-09:30 – Sully3

Measuring the impact of capacity building: do we know what works?

ROSIE TREVELYAN
Tropical Biology Association, David Attenborough Building, Pembroke Street, CB2 3EJ, Cambridge, UK

Biodiversity conservation requires skilled people coupled with the political and institutional support necessary to operate effectively. This is why many organisations focus on capacity building as one of their conservation tools. How effective have these capacity building interventions been? Do some work better than others and is so in what circumstances? What time-frame does capacity building need in order to see tangible results.

My talk will set the scene for the Symposium. I will outline how capacity building is a broad field, drawing on other disciplines such as education theory and psychology in extremely varying degrees.

The debate around how to measure impacts in conservation is now taking place both among providers and funders. I will outline the challenges of measuring impact from capacity building, and use some illustrative examples. Although there is no one set of agreed indicators of success, there are some well-used tools and approaches. There are however, some less well-developed approaches, such as how to measure attribution. My talk, and indeed the symposium, aims to explore where there is consensus on impact measurement and where our approaches need further refining – and sharing with funders.

O39-02 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
Wednesday 22 June / 08:30-09:30 – Sully3

Measuring the intangibles of capacity building for conservation

BETH KAPLIN[1], JEANNETTE BATAMULIZA[2], ERASME UYIZEYE[1]
[1]Antioch University New England and University of Rwanda, Environmental Studies, 05346, Keene, NH and Butare, USA and Rwanda
[2]University of Rwanda, Center of Excellence in Biodiversity, Biology Dept., Butare, Rwanda

Biodiversity conservation project planning and management in many African countries continues to be driven mainly from the west. Higher education institutions in Africa are often not involved in key conservation research activities. In an effort to address this, the Regional Network for Conservation Educators in the Albertine Rift was born in 2008 to strengthen the role of regional universities and research institutions to play key roles in biodiversity conservation. The network is composed of conservation and environmental science educators and researchers at academic and research institutions and NGOs in the Albertine Rift (Rwanda, Burundi, Uganda, DRC, Tanzania). The goal of the Network is to improve biodiversity conservation, environmental management, sustainable development and capacity for climate change adaptation in the Albertine Rift region by strengthening the capacity of member institutions and enhancing collaborative opportunities. The Network emphasizes strengths in the region for biodiversity conservation, seeks to empower and support the voices and work of individuals. But how do we know we have empowered individuals or strengthened capacity in the region? We can quantify research papers or participation in meetings for example. But we are also interested in the difficult-to-quantify aspects of capacity building and empowerment efforts – the ways that individuals are transformed. We want to if we have addressed factors such as the isolation of instructors and researchers in the region, and if we have empowered individuals. Over the past few years we have been working on various approaches to capture the impacts of the network on biodiversity conservation in the region. We found that relatively simply factors such as a list serve to link individuals in academia in the region increased network member access to training and grant opportunities. We also found that the network enhanced collaborative opportunities among universities in the region, and senior staff connect to and mentor students and junior staff across countries within the network. We believe that these changes will take some time before direct links to improved biodiversity conservation are evident, but both the low number of local conservation initiatives and the heavy reliance on external intellectual, conceptual and financial support for biodiversity conservation and climate change adaptation is neither sustainable nor especially effective.

O39-03 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
Wednesday 22 June / 08:30-09:30 – Sully3

Forests, People, and the rest of the world: local participation in REDD+ Measuring, Reporting and Verification (PMRV)

MANUEL BOISSIERE[1], MARTIN HEROLD[2], STIBNIATI ATMADJA[3], DOUGLAS SHEIL[4]
[1]Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Environement et Societés, 34398, MONTPELLIER, FRANCE
[2]Wageningen University, Department of Environmental Science, 6708PB, Wageningen, The Netherlands
[3]Center for International Forestry Research (CIFOR), Forest and Human Wellbeing, 16115, Bogor, Indonesia
[4]Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management, NO-1432, ÅS, Norway

Community's participation has been promoted as a way to empower local communities in REDD+ programs. A particular goal is that they would monitor forest change and measure carbon stocks, and thus reduce the costs of such assessments. More generically, the recent Paris Climate Agreement has further emphasized the need for transparency in reporting, the importance of the land use sector for both mitigation and adaptation, and the fact the targets can only be achieved through bottom-up engagement of multiple actors. So far, little empirical evidence shows that participatory measurement, reporting and verification (PMRV) is feasible.
A series of multidisciplinary studies investigated the feasibility of local participation into MRV. The research was conducted in Indonesia, Vietnam, Ethiopia, Mexico, and China.
We find that effective PMRV requires local communities' motivation. Motivation depends on people's knowledge, their interests, incentives, tenure, and the relevance of these monitoring activities to their other livelihood activities. Monitoring and reporting changes in forest cover, drivers of change, and carbon sequestration, are in general costly and require the capacity to monitor and report. Other sectors provide some relevant lessons and experiences on reporting from village to national levels. In Indonesia, for example, we learned that the health care system has simpler governance for monitoring and reporting compared to the forestry sector and has successfully been in place for more than 40 years. In contrast, the forestry sector failed in engaging local communities in the reporting of timber and non-timber forest products.
Verification refers to assessing the accuracy, consistency and transparency of measurements to verify the attainment of emission reduction targets. We explain how verification can use a combination of remote sensing data, land use and land cover maps developed by/with villagers to identify gaps and points of disagreement, for which ground check will be necessary.
The notion of "independent" monitoring and multi-stakeholder engagement is gaining momentum and the role of participatory approaches linking both monitoring and management will be central. Communities will play a major role in achieving REDD+ but this requires greater attention to their needs and motivations.

O39-04 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
Wednesday 22 June / 08:30-09:30 – Sully3

Community-level Empowerment: How Social and Human Capital are the Drivers of Long-Term Conservation Success

BARBARA VALLARINO
EcoLogic Development Fund, 186 Alewife Brook Parkway, 2138, Cambridge, UK

Empowerment of communities and their leaders means promoting local solutions to natural resource management and conservation in productive landscapes and seascapes that communities control or have influence over. Empowerment through training and organizational accompaniment strengthens the collective action of local communities. It has been noted that many poverty interventions focus on building collective action through community and regional organizations (Naryan 2005). Natural resource management, particularly for food production, water management, and biodiversity conservation can and should also build on collective action of local communities in order to be truly sustainable. An empowering approach to conservation is grounded in the conviction that local communities are crucial partners for conservation, since they are the most motivated to be effective stewards of their natural resources and the environment around them. No one has more at stake in shaping healthy ecosystems that are resilient in the face of climate change than the communities that depend upon them. In this presentation, I dissect the term "empowerment" and offer case studies which illuminate how international conservation NGOs can work appropriately to strengthen community organizations and the skills and knowledge of community leaders and members. I will examine factors of empowerment such as human and social capital, access to power and decision-making, and knowledge of sustainable production methods - and explain how they play out in a real world setting in Central America to maximize the opportunities available for conservation and sustainable livelihoods despite the constraints or absence of effective government at other levels.

O40-01 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

The Architecture of Tropical Trees

FRANCIS HALLÉ
University of Montpellier (retired), Department of Biology, 34090, Montpellier, France

This keynote address will address 5 main problems or questions concerning plant architecture today:
- Is ecology triggering the architecture? Are these two domains quite independent from each other?
- One same architectural model appears frequently in two plant families having no close relationship ; what does this mean for the evolutionists?
- When are we going to see geneticians studying plant architecture, and vigorously determined to really solve the problem?
- How can we explain the obvious link between architecture and latitude: tropical trees displaying high architectural diversity vs. temperate herbs having very few simple models?
- Why is it so difficult to attract the interest of field botanists, although architecture is so easy to observe and so relevant to plant identification?

O40-02 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

New quantitative concepts on tree architecture and whole plant functioning

FRANK STERCK[1], GIAI PETIT[2], MARK OLSEN[3], TOMMASO ANFODILLO[2]
[1]Wageningen University, Forest Ecology and Forest Management, 6700AA, Wageningen, the Netherlands
[2]Università degli Studi di Padova, Dept. Territorio e Sistemi Agro-Forestali, I-35020, Legnaro, Italy
[3]Universidad Nacional Autonoma de Mexico, Instituto de Biologia, 04510, Mexico DF, Mexico

Background: Our insights on tree architecture, allocation, physiology, performance and selection have considerably moved forward over the last 4 decades, but the integration of those concepts is still in its infancy because these separate topics were dealt with in different disciplines. Very broad-scale species comparisons underpinned the innovative insights of Halle and colleagues, and also provide the base of the new insights provided by studies on functional traits, with major focus on leaves, but also on stems. Yet, insights from functional leaf or stem traits alone remain limited as long as they cannot be scaled to whole plants. We present a quantitative concept, which integrates architecture, allocation, physiology, performance and natural selection of trees, and show how such integration can provide new answers to questions on the role of tree architecture in whole plant functioning.
Method: We measured whole trees and branches for their leaf area, sapwood area and phloem area across a range of environments, and measured leaf traits that refer to photosynthesis, transpiration and respiration, and wood traits that refer to mechanical strength, conductance for water, and construction costs.
Result and Discussion: We show how natural selection converges tree architecture across species, from the perspective of scaling relationships such as the leaf area: sapwood area (or mass) and the leaf area: phloem area (or mass) ratio. Despite the convergence, species differences in those relationships can be explained by differences in tissue/organ anatomy and physiology on the one hand, and divergent growth strategies on the other. We speculate that trees in resource poor conditions (e.g. mountain forest) grow slow and remain smaller than trees at resource rich conditions (lowland forest). Yet, by having a higher leaf: sapwood mass ratio, they acclimate to the poorer conditions and therefore do not differ in mortality risks. Only under extreme conditions for either site (e.g. a dry year, or disturbance such as defoliation), trees come under stress when they cannot maintain their leaf: sapwood mass ratio, and then risk higher mortality. We thus show how a new quantitative framework can integrate rather separately studied traits of architecture, allocation, physiology, performance and selection, and shed new light on acclimation and stress as faced by plants.

O40-03 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

Exploring the scaling of tree branching architecture across the tropics

LISA PATRICK BENTLEY[1], ALEXANDER SHENKIN[1], IMMA OLIVERAS[1], ERIKA CAMILA DE OLIVEIRA[2], JIMMY CHAMBI PAUCAR[3], RENATA FREITAG[2], AGNE GVOZDEVAITE[1], MILENKA MONTOYA PILLCO[3], MARGOT NEYRET[4], THERESA PEPRAH[5], NORMA SALINAS[6], STEPHEN ADU-BREDU[5], GREGORY ASNER[7], SANDRA DIAZ[8], BRIAN ENQUIST[9], BEATRIZ SCHWANTES MARIMON[2], BEN-HUR MARIMON-JUNIOR[2], YADVINDER MALHI[1]
[1]University of Oxford, School of Geography and Environment, OX1 3QY, Oxford, UK
[2]UNEMAT, Ecology and Conservation Unit, 78690-000, Nova Xavantina, Brazil
[3]Universidad San Antonio Abad de Cusco, Biology, 08003, Cusco, Peru
[4]École Normale Supérieure, Ecology, F-75230, Paris, France
[5]Forestry Research Institute of Ghana, Forestry, P. O. Box UP 63 KNUST, Kumasi, Ghana
[6]Pontificia Universidad Católica del Perú, Chemistry, 32, Lima, Peru
[7]Carnegie Institution for Science, Global Ecology, 94305, Stanford, USA
[8]Universidad Nacional de Córdoba, Instituto Interdisciplinario de Biología Vegetal (CONICET-UNC) y FCEFyN, 5000, Córdoba, Argentina
[9]University of Arizona, Ecology and Evolutionary Biology, 85721, Tucson, USA

Background: In structural botany, especially classical plant anatomy and morphology, principles of organization, pattern, and form of trees have been sought to classify and perhaps explain plant diversity. Today, plant scaling models use measurements of architecture (i.e., length, width, and order of branch or xylem segments) to ultimately predict whole-plant metabolism via mass and water-use allometries. However, in order to use scaling models, we must explore the extent to which patterns of tree form consistently scale between branches and the whole tree, via branching traits related to tree form. As such, it is still unclear to what extent simple geometrical models approximate tree communities, and where important functional divergences from theory exist.
Methods: Branches were collected from rainforest tree canopies across tropical regions in Peru, Brazil and Africa. Branch topology was recorded and branch segment length and diameter measured. Power-law exponents were calculated for the scaling of branch length and branch diameter at a species-level across sites. In addition, tree crown dimensions (width, depth, volume) were measured for all trees with collected branches.
Results: Scaling of branch radii is similar across sites and overlaps with metabolic scaling theory's prediction. Scaling of branch lengths is different across sites and does not always overlap with theory's prediction. Path fraction (Pf; mean hydraulic path length/maximum hydraulic path length) varies significantly among branches. For example, along the Peru elevation gradient, trees at the lowland site have Pf values representative of deeper canopies and trees at tree line and in the cloud forest have Pf values representative of shallower canopies.
Discussion: Recent data across the tropics show differences in aboveground biomass of forests. Our results indicate that some of these differences in biomass are due to structural differences in branching architecture. Furthermore, our results across different regions in the tropics allow for the extrapolation of information regarding the influence of the environment (e.g., temperature, light) on variation in branching architecture traits and how this variation affects scaling. Based on canopy dimension data, it seems that accounting for branch light environment is key to accurately estimating whole tree metabolism within a scaling framework.

O40-04 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

The shape of trees across the tropics: environmental and evolutionary roles in crown metabolic scaling.

ALEXANDER SHENKIN[1], IMMA OLIVIERAS[1], LISA BENTLEY[1], NORMA SALINAS[1], EFRAIN LOPEZ[2], LUCIO TRUJILLO[2], EDITH EZQUERRA[2], ASNER GREGORY[3], DIAZ SANDRA[4], ENQUIST BRIAN[5], MALHI YADVINDER[1]
[1]University of Oxford, Environmental Change Institute, OX1 3QY, Oxford, UK
[2]Universidad Nacional de San Antonio Abad del Cusco, Departmento de Biologia, NA, Cusco, Peru
[3]Carnegie Institution for Science, Department of Global Ecology, 94305, Stanford, CA, USA
[4]Universidad Nacional de Córdoba, Instituto Multidisciplinario de Biología Vegetal, Consejo Nacional de Investigaciones Científicas y Técnicas de Argentina, Facultad de Ciencias Exactas, Físicas y Naturales, 5000, Cordoba, Argentina
[5]University of Arizona, Department of Ecology and Evolutionary Biology, 85721, Tucson, AZ, USA

Background: The relationship between the size and shape of a tree's stem and its crown ("allometry") has been a topic of research for over a century. Recent research debates the roles of abiotic environment, biotic community, and evolution in this relationship, largely concluding that variation is limited and that allometries tend to converge. The fundamental control over this allometric relationship is also debated. Metabolic scaling theory, based on laws that govern body sizes in animals, was applied to crown allometry in 2009 and remains controversial.
Methods: Across over 1000 trees in 10 1-ha plots in an elevation transect in Peru, and 4 plots in Ghana and 7 plots in Brazil across forest-savanna transitions, we measured tree stem diameters, tree heights, and 10 – 20 points around the associated tree crowns to estimate crown dimensions. Using semi-major axis regression and linear mixed models, we tested whether metabolic scaling theory accurately predicted the scaling coefficients, and how phylogenetics and different ecotypes influenced those coefficients.
Results: When modelled by accounting for variation between species, our data fits the metabolic scaling theory predictions remarkably closely. We find that ecotype does affect crown allometry, but not in easily predictable ways. There were consistent phylogenetic patterns in allometry, with certain legume clades exhibiting larger than expected crowns across continents.
Discussion: This study represents, to the knowledge of these authors, the first examination of tropical tree crown allometry across multiple continents and ecotypes, and is also the first to examine these allometries in relation to phylogeny. Our data indicate that while biotic and abiotic conditions exert some control over crown scaling, evolution plays a discernible role as well. Overall, metabolic scaling theory predicts our data remarkably well, lending support to that model.

O40-05 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

Interspecific variation in tropical tree height and crown allometries in relation to life history traits

ISABEL MARTINEZ[1], HELENE C. MULLER-LANDAU[2], S. JOSEPH WRIGHT[2], STEPHEN W. PACALA[1]
[1]Princeton University, Ecology and Evolutionary Biology, 08544, Princeton (NJ), USA
[2]Smithsonian Tropical Research Institute, 0843-03092, Balboa, Ancón, Panama

Background: Height and crown allometries play a central role in forest ecology, particularly in the estimation of forest carbon storage and primary production, and in mechanistic modeling of these processes. These allometric relationships are often modeled by fitting power functions to pooled data from multiple species. However, empirical relationships often deviate substantially from power functions, especially at large tree sizes, and there is substantial interspecific variation in allometries.
Method: Here, we analyzed tropical tree height and crown area allometric relationships using species-specific morphological and life history data from Barro Colorado Island, Panamá, including data on height-diameter allometries for 9885 trees and on crown area – diameter allometries for 2425 trees of 162 species. We compared alternative functional forms relating height and crown area to trunk diameter, including power functions, Weibull functions, and Michaelis-Menten functions. We analyzed data for multiple species under a Bayesian framework, using hierarchical models in which species' allometric parameters were related to shade tolerance and functional traits.
Results: Allometric models allowing for a curvature in scaling provided a better representation of the scaling of height with trunk diameter but not for crown area. Hierarchical models incorporating effects of species' wood density or shade-tolerance on allometric parameters outperformed those with purely random species effects. For example, the exponent for the increase in tree height with trunk diameter was positively related to sapling growth rates. On the other hand, tree species with high wood density had larger crowns at any size diameter.
Main conclusions: Our analyses clearly demonstrate that tree height is best represented as decelerating functions of trunk diameter. Power functions were systematically biased to overestimating height of the largest trees, which are disproportionately important to forest carbon budgets. Our results also better quantify how interspecific variation in allometry is related to life history strategy and functional traits, particularly shade-tolerance and wood density. They thus provide an improved basis for parameterizing tropical tree functional types in vegetation models.

O40-06 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

Quantifying diurnal leaf movement and radiative transfer in tropical forests

KC CUSHMAN[1], STEVEN HANCOCK[2], CARLOS SILVA[1], JAMES KELLNER[1]
[1]Brown University, Institute at Brown for Environment and Society, 02912, Providence, USA
[2]University of Maryland, 2Departmet of Geographical Sciences, 20742, College Park, USA

Background: Many plants can change their leaf orientation either to maximize interception of sunlight and increase photosynthesis, or to avoid excess sunlight and reduce damage of photosynthetic pigments. These heliotropic leaf movements have been described at the scale of individual plants to characterize photosynthetic capacity (for instance, a heliotropic plant experiencing water stress will avoid direct sunlight). However, the importance of this phenomenon for photosynthetically absorbed radiation at the scale of entire landscapes is unknown. In this study, we evaluate a methodological framework for quantifying diurnal leaf movement in tropical trees and discuss the implications for radiative transfer through the canopy.
Methods: We used a compact laser scanner to measure the three-dimensional structure of vegetation at fine spatial scale and high temporal frequency. We differentiated laser returns from leaf material vs. non-photosynthetic vegetation by the return strength of the laser (1545 nm wavelength). We characterized changes in leaf angle using a modified gap fraction method that compares the contact frequency of lasers emitted at different angles.
Results: Our laser scanner platform collected structural information at very fine spatial (> 1,000 points/square meter) and temporal resolution (multiple measurements per day). For plants with known heliotropic movements, we discuss the capability of using our data to assess leaf orientation.
Discussion: Leaf movement allows some canopy trees to either maximize or minimize intercepted light, thereby controlling the amount of light reaching the understory. By observing these changes, we can gain insight into daily patterns of production at the level of entire communities. Recent advances in instrumentation and data collection platforms, such as small laser scanners and unmanned aerial vehicles, may allow data to be collected at sufficient spatial and temporal resolution to quantify diurnal patterns in radiative transfer over scales that are relevant for landscape level productivity.

O40-07 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
Wednesday 22 June / 10:00-12:00 – Sully3

Light environments in intact and degraded Atlantic forests: from measurements to modelling

SOPHIE FAUSET[1], MANUEL GLOOR[1], CARLOS JOLY[2], SIMONE VIEIRA[3], ALEXANDER SHENKIN[4]
[1]University of Leeds, School of Geography, LS2 9JT, Leeds, UK
[2]State University of Campinas, Plant Biology, 13083-970, Campinas, Brazil
[3]State University of Campinas, NEPAM, 13083-970, Campinas, Brazil
[4]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, UK

Background: The Atlantic forests of Brazil are some of the most heavily cleared tropical forests globally. With just 12 % of the original extent remaining, much of the forest is located either in small fragments in mosaic agricultural-pastoral landscapes, or in larger fragments on steep mountainsides. Due to a long history of human impact since European colonization, many of these forests are secondary. Hence, the forest structure is highly variable from relatively intact and largely forested areas, to small secondary forest fragments with strong edge effects. Forest structure impacts the light regime within the forest canopy, and has a strong influence on physiological processes.
Method: This project is a part of the wider ECOFOR human modified tropical forests project. Here we focus on investigating differences in the vertical light environment of forests with differing histories of degradation, test if we can model such differences based on forest structures, and use a process-based model to investigate the impact of variation in light on forest productivity.
Results: We found variation between different levels of degradation and light profiles. Intact and secondary forests both showed exponential declines in light with depth through the canopy. However in the logged forest the light profile was 'S' shaped. In secondary fragments light decline was linear.
Our forest model was able to reproduce some differences in light profiles, and altering profiles resulted in changes in the carbon balance of small trees.
Conclusion: We present novel data on light environments of degraded forests, and find that lateral light is very important for logged forests. Using a process-based forest model, we find that the growth of small trees depends on the light regime.

O41-01 – S41 *Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned*
Wednesday 22 June / 14:00-15:30 – Sully3

Distributed Graduate Seminar in Sustainability Science: Cross-cultural Learning with a Low Carbon Footprint

PATRICIA BALVANERA[1], JEANNINE CAVENDER-BARES[2], CARLOS GONZALEZ[1], LUCIA LOHMANN[3], STEVE POLASKY[4], OSVALDO SALA[5], B.L. TURNER II[6], TUYENI MWAMPABA[1]
[1]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58090, Morelia, Mexico
[2]University of Minnesota, Department of Ecology, Evolution and Behavior, 55108, Saint Paul, USA
[3]Universidade de São Paulo, Instituto de Biociências, 05508-090, Sao Paolo, Brasil
[4]University of Minnesota, Department of Ecology, Evolution and Behavior and Department of Applied Economics, 55108, Saint Paul, USA
[5]Arizona State University, School of Life Sciences and School of Sustainability, 85287-5502, Tempe, USA
[6]Arizona State University, School of Geographical Sciences & Urban Planning and School of Sustainability, 85287-5502, Tempe, USA

Background: Some of the most difficult questions in sustainability result from contrasting values and world-views. Given that global sustainability challenges are intertwined across cultures and different regions of the globe, it is critical to understand contrasting perspectives about sustainability. Teaching graduate-level sustainability science not only requires the acquisition of key concepts but also the understanding of contrasting approaches and values from different social-ecological and cultural contexts. Here, we present a novel approach to teach sustainability science through a distributed graduate seminar that involves several institutions of the Western Hemisphere.
Methods: The course, with 6-8 instructors from multiple disciplines, is taught simultaneously by 3-5 institutions over 16-weeks. Each week, a different instructor or guest instructor provides 2-4 key papers and a powerpoint lecture shared on an online platform and discussed independently at each institution. A joint online session involving all participating institutions is then held for 1.5 hours. During the first 30 mins of the joint session, the lead instructor for the week gives a lecture, which is followed by a general discussion focusing on questions formulated by each Institution during the independent sessions. The joint session is recorded and permanently available to all course participants.
Results and Discussion: A total of ca. 200 participants distributed across 8 campuses in the US, Mexico and Brazil have participated in 6 iterations of the course since 2010. The resulting interactions have led to the publication of a book chapter, a special issue of the journal Ecology and Society that included 9 contributions from faculty and students from the course, a public website with materials derived from the 2015 course-iteration, 4 presentations at international meetings, and multiple student collaborative essays. Some of the key lessons learned are the following: (i) paper discussions held at each institution individually were critical for the identification of key issues at stake; (ii) different insights often emerged from the various institutions; (iii) contrasting interpretations and approaches to sustainability science between the global north and the global south allowed us to the respectfully engage a variety of issues, such as equity, norms and values; and (iv) key concepts and fundamental components were shared across institutions enhancing collective understanding.

O41-02 – S41 *Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned*
Wednesday 22 June / 14:00-15:30 – Sully3

Using the case-study approach for sustainability education: The example of socio-hydrological risk in Mexico City

CHARLI-JOSEPH LAKSHMI[2], EAKIN HALLIE[1], ESCALANTE ANA E.[2], TELLMAN BETH[1], LERNER AMY M.[2]
[1]Arizona State University, School of Sustainability, 85281, Tempe, USA
[2]Universidad Nacional Autónoma de México (UNAM), Laboratorio Nacional de Ciencias de la Sostenibilidad (LANCIS), 04510, Mexico City, Mexico

Teaching sustainability science requires innovative pedagogies that allow students to grasp the complexities of socio-ecological systems (SES). The case-study approach is one method that can enable students and instructors to explore such complex dynamics, through activities and discussions focused on a real-world example. Our aim was to create a case that enables students to grapple with the complexity of SES interactions and to synthesize data and ideas from both the natural and social sciences.
We utilized empirical data from the "MEGADAPT" project, a NSF-funded international and transdisciplinary research project focus on water resource management in Mexico City as the basis for our case. We used conceptual modeling tools, a stakeholder analysis framework, qualitative data analysis techniques and agent-based modeling as instruments to both convey meaning about SES interactions as well as introduce students to effective tools that they could then use in their own research. The case development entailed devising ways in which students could both evaluate SES interactions "objectively" using available secondary literature and data, while also understanding how the position of influence and interest of actors within a system can have implications for the systems' dynamics. Our aim was to thus bring attention to the role of human agency and cognitive structures in the complex problem of water, thus addressing cross-scalar and intersubjectivity in social-ecological interactions.
We found that students were able to grapple with the cultural, biophysical and political complexity of Mexico City through the case study exercises with no prior experience in Mexico or knowledge of the city's challenges. Using system-mapping exercises, the students were able to evaluate how subjectivity and positionality affect "entry points" into system dynamics, and thus solution pathways. The Agent Based Modeling component of the course was particularly constructive in helping students understand how differential priorities of decision-makers can affect vulnerabilities in the system, and how tradeoffs can occur in addressing vulnerabilities.
The case provides a compelling example of how issues of scale, tradeoffs, power and positionality can be incorporated into instruction on SES analysis. We find that teaching through visualization tools such as system mapping is constructive, and that these tools can be used to incorporate actor-oriented perspectives and insights.

O41-03 – S41 *Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned*
Wednesday 22 June / 14:00-15:30 – Sully3

Using case studies to teach synthesis and analysis of complex sustainability challenges

MARION RIENSCHE[1], TUYENI H MWAMPAMBA[1], CHANTELISE PELLS[2], MATT ROBBINS[2], PATRICIA BALVANERA[1]
[1]National Autonomous University of Mexico, Campus Morelia, Institute of Ecosystems and Sustainability Research, 58190, Morelia, Mexico
[2]University of California Davis, Environmental Science and Policy Department, 95616, Davis, United States

The nature of today's environmental challenges requires sustainability science courses to introduce students to complexity and to empower them to disentangle the issues at stake. Tools that allow students to familiarize themselves with the different versions of a 'problem', and to ultimately propose viable solutions are most urgently needed.
Case studies can be powerful tools for teaching sustainability concepts and content, as well as process skills and critical thinking. We developed a 5-module case study and subsequently applied it in a semester-long upper-level environmental science undergraduate course. We tested the usefulness of the approach for strengthening concepts introduced during traditional lecture periods, and for developing students' ability to unpackage complex environmental problems with interdisciplinary lenses. The case was applied into a series of sessions using a set of tools, ranging from drawing conceptual frameworks, identifying key issues and opportunities, as well as conflict dramatization. At the end of the semester, students' and instructors' evaluations were used to determine whether learning objectives had been achieved, and how to adjust the case to address shortcomings.
Students reported great overall experience; they considered it helped ground concepts and provided them with tools to deal with the overwhelming complexity. Disgruntlement did emerge related to the absence of a process to resolve the problems they had identified and thus bring closure to the case. The experience highlighted key considerations in designing and implementing case studies that may be specific to teaching sustainability science.

O41-04 – S41 *Teaching sustainability science at university level: cross nation experiences, differing approaches, and important lessons learned*
Wednesday 22 June / 14:00-15:30 – Sully3

Teaching sustainability science from a systems analysis perspective: MSc course at Utrecht University

MARIA J SANTOS, HUGO DE BOER, STEFAN DEKKER
Copernicus Institute of Sustainable Development, Department of Innovation, Environmental and Energy Sciences, Utrecht University, 3508TC, Utrecht, The Netherlands

Sustainability science has emerged as a key discipline that embraces both disciplinary depth and interdisciplinary breadth. The challenge is to design University courses that convey both depth and breadth. Here we present the design of such course at Utrecht University (the Netherlands) for the Sustainable Development MSC program, which attracts students with diverse backgrounds. Our course (Sustainability Science: Modelling and Indicators (SSMI)) follows an introductory course on Sustainability Perspectives. SSMI philosophy is that systems analysis is central to sustainability science. Through a systems analysis framework mathematical descriptions can be decomposed in easily understandable components as states, flows and feedbacks. To convey this philosophy, we developed four hands-on exercises that aim to build-on complexity and make use of different software (Stella, Excel, IMAGE and Netlogo). The assignments aimed at: (1) teaching students the system components by using a pre-existing model in Stella, (2) challenge students to build their own coupled system in Excel, (3) assess outputs from a fully-coupled and dynamic model in IMAGE, and (4) understand emergent properties using an agent-based model in Netlogo. We found that the mathematics presented a challenge to a part of the students, but were still doable. Our student pool (n=110) identified a priori having higher experience with Excel in comparison with other software. The student learning curve was steep. Netlogo was the highest ranked software in the student evaluations and this was linked to its user-interface with moving agents, and perhaps because students from social sciences related to concepts behind this type of model. The Excel assignment received the highest and lowest scores, and students found it challenging, time consuming but also indicated that they learned the most. Students graded what we considered 'easy' assignments with the highest grades. These results suggest that a systems analytical approach to sustainability science can be operationalized in diverse ways that relate to students background and making use of of-the-shelf software. The key challenge is to teach students all the concepts of systems analysis and the applied mathematics behind it. If the goal is to demonstrate process, this portfolio approach with of-the-shelf software can be very successful. SSMI can be complemented with programming that provides skills to modify and customize software to student needs.

O42-01 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

Developing research capacity in biological conservation and wild life management: a Caribbean perspective.

FRANK CÉZILLY[1,2], JULIETTE BAILLY[2]
[1]Université de Bourgogne – Franche Comté, UMR CNRS 6282 Biogéosciences, Dijon, France
[2]Caribaea Initiative, La Tour du Valat, 13200 Arles, France

Background - Although the Caribbean region is the fifth hotspot of biodiversity in the world, scientific research on Caribbean biodiversity and wildlife conservation is insufficiently developed. Our aim here is to proceed to a review of the literature in order to assess which topics have been covered so far, in which areas important gaps in knowledge still remain, and what is the contribution of local research institutions relative to that of external research institutions.
Method - We surveyed the existing literature to quantify the scientific production on biodiversity and wildlife conservation in the Caribbean, in terms of articles published in international refereed journals. This was mainly achieved through using combinations of key words to extract the relevant information from the Web of Science. Parallel to this, we assessed the existing human resources for developing research on biodiversity and conservation in key Caribbean institutions.
Results - Our results show that, compared to that of other geographical regions, the Caribbean biodiversity has received less attention, in terms of scientific research, at least from what can be concluded based on our literature survey. This deficit can be partly explained by the lack of local scientific expertise, although several other factors contribute to the situation.
Discussion - We make some recommendations for strengthening transnational cooperation in research on biodiversity and increasing academic production on Caribbean biodiversity.

O42-02 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

Developing training in veterinary sciences and conservation medicine in the Caribbean: the case of Ross
University School of Veterinary Medicine in St. Kitts

DARRYN KNOBEL, NATHALIE MATHER-L'HUILLIER, JEREMY DERICCO, LEE WILLINGHAM
Ross University School of Veterinary Medicine, P O Box 334, BASSETERRE, St Kitts

Background– Ross University School of Veterinary Medicine (RUSVM) in St. Kitts and Nevis offers training programs in wildlife health and conservation medicine in the Caribbean. RUSVM provides a learning environment that prepares our students to become leaders in these fields, supported by a research-informed educational experience. Research is focused on advancing human and animal health through a transdisciplinary, One Health approach. Method – The Doctor of Veterinary Medicine (DVM) program at RUSVM is a 10-semester (3 years and four months), research-active program accredited by the American Veterinary Medical Association and the St. Christopher & Nevis Accreditation Board. DVM students with an interest in conservation medicine can take elective courses such as Introduction to Sea Turtle Medicine, and Introductory/Advanced Aquatic Veterinary Medicine, as well as being involved in conservation programs through assistantships, student-led research electives and volunteer opportunities. Postgraduate degree programs include a Master of Science (by coursework) in One Health, as well as MSc and PhD by research. The MSc in One Health has a strong emphasis on leadership, research and communication, as well as modules in conservation medicine, disease surveillance and diagnostics, zoonotic diseases, epidemiology and biostatistics. Results – Research capacity on biodiversity and conservation at RUSVM lies within the Center for Conservation Medicine and Ecosystem Health. The Center is focused on two overarching research themes: (i) the health of indicator species in marine ecosystems in the Caribbean, and (ii) the population ecology, disease epidemiology and management of non-native fauna in the Caribbean. In marine ecosystems, the Center has a focus on sea turtles, invasive lionfish, marine mammals, corals, and queen conch populations. In terrestrial ecosystems, the focus is on feral cats and donkeys, free-roaming dogs, African green monkeys and small Indian mongooses. Discussion – Through engagement with diverse partners in the region and beyond, RUSVM is well placed to contribute to the development of research capacity in wildlife health and conservation medicine in the Caribbean, including training of future veterinarians.

O42-03 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

The University of the West Indies: building research capacity for biodiversity conservation in the Caribbean

VALLÈS HENRI
Department of Biological and Chemical Sciences, The University of the West Indies, Cave Hill Campus, P.O.Box 64, Bridgetown, Barbados

The University of the West Indies (UWI), established since 1948, is the largest university in the English speaking Caribbean and the only regional one, with campuses in Trinidad and Tobago (St Augustine), Jamaica (Mona), and Barbados (Cave Hill). It is host to approximately 50,000 registered students from 18 countries in the Caribbean region and outside. Through its three campuses, the UWI offers a range of undergraduate and post-graduate degrees in the biological sciences and related fields. This communication (1) provides an overview of the different UWI undergraduate and post-graduate programmes that are relevant to biodiversity and conservation in the Caribbean; (2) underlines recent research at UWI in those areas, and (3) highlights challenges that UWI faces in strengthening its research capacity.

O42-04 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

Integrating Tertiary Education on Biodiversity Conservation with Island Needs

VIERA FRAGOSO JOSÉ MANUEL
California Academy of Sciences, California, USA

Creating a successful graduate program in biodiversity conservation for islands can be challenging. Limited land area results in intricate land use patterns and cultural resistance to sustainably managing remaining natural environments. I describe how a Coupled Natural-Human Systems approach can generate greater opportunities in these socio-ecological environments for such programs and their graduates. It can also lead to more success in biodiversity and wildlife conservation.

O42-05 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

The ECOTROP Master's degree of the Université des Antilles: a tool for promoting biodiversity conservation in the Caribbean

DANIEL IMBERT
Université des Antilles, UMR EcoFoG, CNRS, Cirad, INRA, Université de Guyane, 97159 Pointe-à-Pitre, France

Background- French overseas territories account for the largest islands of the Lesser Antilles and host much of the biodiversity found in this sub-region. As a result, national policies for nature conservation have led to the establishment of several kinds of specially protected areas across those islands, enabling an increasing local concern for sustainable management programs and for scientific research on Caribbean biodiversity. Consecutively, the Université des Antilles has developed since 2001 a Master level program on the ecology and management of tropical biodiversity.
Method- The ECOTROP Master's degree was launched in 2010. We analyse the influx of students who applied for this program over the last 6 years, and we highlight the success and failure rates as well as the origin of the students. The future of the graduates is assessed by means of an on-line survey run on a sample of 52 responses. Results- The Master welcomes each year an average of 42 students. 21% of them come from abroad, mostly from Western Europe through the Erasmus student exchange program. Caribbean students account only for 25% of the graduates. At the time of the inquiry, 79% of the graduates had found a job or a doctoral grant in accordance to their diploma. On average, a same proportion of students find a job within the next 18 months following their graduation. Half of the graduates find their first job in their own country/state and 67% of these jobs are located in tropical areas.
Discussion- Despite an especially favourable context to maintain an advanced training program on tropical biodiversity and wildlife conservation at the Université des Antilles, much remains to be done to improve the number of local and foreign Caribbean graduates.

O42-06 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
Wednesday 22 June / 16:00-17:30 – Sully3

Developing cooperation capacity in biodiversity conservation: the French West Indies (FWI) territories perspectives.

JEAN-RAPHAËL GROS-DÉSORMEAUX, JUSTIN DANIEL, KARINE GALY
[1]Université des Antilles – Martinique, UMR CNRS 8053 CRPLC, Schoelcher, France (FWI)

Background - In March 2016, the French National Assembly has unanimously adopted a law about external actions of local authorities and cooperation between the French overseas territories and their regional environment. This new possibility of alliances between states and local authorities offers an opportunity for liaising with political, economical, intellectual and scientific circles in the «Greater Caribbean», especially for the natural heritage conservation in this fifth hotspot of biodiversity in the world. In this context, the aim of this proposal is to present and to analyse the new opportunities arising from the French Agency of Biodiversity strategy and the Biodiversity French Law project.
Method - The methodology used here is based on Textual Data Analysis (Gibbs, 2002). This qualitative approach combines a set of statistical methods for to discover the important information in texts. This is an interesting alternative for to minimize bias in the analyse of two important texts: «Projet de loi pour la reconquête de la biodiversité, de la nature et des paysages» and the report intituled «Quelles déclinaisons de l'Agence française pour la biodiversité dans les outre-mer».
Results - In the results, we will highlight categorical idea, the words and sentences most used, all repeated segments in the text, the similarities and the differences between the frequent worlds.
Discussion - From the results, we will propose to discuss the need to build an innovative formation to support the development of Caribbean cooperation capacity in environmental diplomacy, especially with the recent "eco-diplomacy Master's degree project" between the non governmental organisation Caribaea initiative, the University of the West Indies, the Université des Antilles and the Université de Bourgogne.
REFERENCES: Gibbs, Graham. Qualitative data analysis: Explorations with NVivo (Understanding social research). Buckingham: Open University Press, 2002.

O43-01 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Stable isotopes reveal the region of origin of tropical timber

MART VLAM[1], ARNOUD BOOM[2], PIETER ZUIDEMA[1]
[1]Wageningen University, Forest Ecology and Forest Management, 6700AA, Wageningen, The Netherlands
[2]University of Leicester, Department of Geography, LE1 7RH, Leicester, UK

It is estimated that up to 50% of the tropical timber entering the EU market is illegally harvested. The trade in illegally harvested tropical timber disrupts economies and ecosystems in the countries of origin, undermines environmentally sustainable alternatives and reduces the options for future use of our natural resources. To combat this illegal trade the EU timber regulation was implemented in March 2013 prohibiting any illegally sourced timber from entering the EU market. This increasingly demands for ways to verify the claimed origin of tropical timber based on the wood itself, rather than on trade documents that may have been forged. Stable isotopes provide a means to independently trace the geographic origin of tropical timber, because the wood isotopic composition is determined by the growing conditions of the tree and thereby for the region of origin of its timber.
We use three naturally occurring stable isotopes in wood, δ18O, δ15N and δ13C, to determine region of origin of commonly traded tropical timbers. For this study wood samples of two African timbers, tali (Erythrophleum ivorense) and sapeli (Entandrophragma cylindricum), were collected throughout their native range in tropical Africa. Of each tree the wood isotopic composition was then determined.
Wood isotopic composition varies both regionally and locally. As expected wood δ18O values show a significant positive correlation with the isotopic composition of rainwater. Within site variation of wood δ13C values are high, often obscuring site of origin. When combining wood δ18O and δ13C values, however, clustering of sites and regions occurs. We show that this site clustering can be used to assign timber samples of unknown origin to their most likely region of origin.
The isotopic composition of wood shows consistent patterns across regions. These patterns are also consistent across genera and families. To acquire higher (<100 km) spatial resolution additional methods will be required, for example DNA fingerprinting and population genetic analyses. Determining geographic origin of timber therefore requires a step-wise approach, in which multiple tracing methods can be used based on the spatial resolution required. In this setup stable isotopes may provide a fast and cost-effective first indication of the region of origin of the timber.

O43-02 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Rationalising Amazonian conservation planning: opportunities of a watershed scale approach

DAVI TELES, CARLOS PERES
University of East Anglia, School of Environmental Science, NR47TJ, Norwich, United Kingdom

Current resource shortages coupled with accelerated rates of biodiversity loss calls for effective proactive approaches in protecting the Earth's remaining wildland areas. The co-occurrence of high biodiversity areas and high levels of anthropogenic disturbance aggravates conflicts of interest between conservation imperatives and economic sectors of society in terms of where best to site viable protected areas (PAs), exposing a tradeoff between reserve size and optimal reserve positioning. A major challenge in creating PAs is therefore to maximize its socio-politically and financially affordable size while placing it in the most strategic locations. Systematic conservation planning to be effective in this scenario needs to be based on geographic units that are ecologically relevant targets for both biodiversity persistence and vulnerability to anthropogenic threats. Here, we propose the use of mega and meso watersheds as conservation planning units for the world's largest remaining tropical forest region. A nested hierarchical structure of fluvial basins ensures a more adequate management strategy that considers the spatial distribution of specific conservation targets; provides rational design options for PAs of varying denominations; and simplifies their de facto defensibility against external threats. This framework remains most effective in vast roadless subregions, which still represents a large fraction of Amazonia. Using a remote sensing approach, we systematically assessed the conservation and vulnerability status of all major Amazonian river basins, examining the congruence between conservation threats and opportunities. We then focused on a single major watershed as a case-study and used decision support algorithms to propose how conservation investments should be allocated to that watershed. Finally, we evaluate how existing protection efforts within major watersheds match the biodiversity conservation value and vulnerability to human perturbation across the entire Amazonian biome.

O43-03 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Landscape-scale sustainability of Amazonian fisheries

JOSEPH E. HAWES[1], JOÃO V. CAMPOS-SILVA[2], CARLOS A. PERES[1]
[1]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK
[2]Universidade Federal do Rio Grande do Norte, Departamento de Ecologia, 59072-970, Natal, Brazil

Much work on tropical forest disturbance has focussed on overhunting of terrestrial animals. Freshwater bodies and wetlands, in contrast, have been relatively neglected, despite high human pressure and the importance of aquatic species for the subsistence and commercial interests of local people. Lowland Amazonia supports the largest expanse of seasonally flooded forests and the most species-rich fish fauna on Earth. It also represents the largest and most valuable freshwater fishery and the highest per-capita fish protein intake. Most major tributaries of the Amazon are now severely overexploited, yet quantitative assessments to inform effective management are scarce.
We assess the fishery of the Médio Juruá region, Brazil, employing comprehensive monitoring of fish landings at the port of Carauari over two years (2014-2016). In addition to volume and species composition of catches, we recorded boat capacity, engine size and fuel costs, trip duration, fishing gear, and the number of fishermen to calculate catch-per-unit-effort (CPUE) for each trip. Market values for each fish species were tracked throughout the year to calculate gross and net earnings, and we georeferenced the maximum extent of all fishing trips.
The composite harvest from over 2,000 fishing trips logged included 36 fish species, and biomass totalled over 562 T (281 T/yr). Irrespective of the effects of seasonality, we found a strong effect of distance from market on CPUE and fishermen selectivity, with fishermen travelling farther for higher valued species. Lake protection by local community-based conservation schemes was shown to be a successful measure to reduce commercial exploitation, over and above any effect of officially designated protected areas, highlighting the value of this approach in sustainably managing fish stocks.
Our study demonstrates the potential for monitoring fish landings in rural Amazonia to quantify current harvests and assess their sustainability. This combination of ecological and economic data is vital to explore the potential social and environmental consequences of overfishing. Combining urban population levels with fish consumption rates allows calculation of the surplus harvest destined for Manaus, Amazonia's principal port and major urban centre. Despite its size and importance, fish landings in Manaus are not currently monitored, so our study provides a valuable baseline to estimate the catchment area of this market into remote Amazonian tributaries.

O43-04 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Thermal ecology of an invasive tropical fish

ALFREDO OJANGUREN
The University of St Andrews, Centre for Biological Diversity, KY16 8TH, St Andrews, UK

Background: Invasive species succeed in places where conditions are remarkably different from those found in their native habitat. Guppies are native to northeast South America, where environmental conditions are typically tropical with water temperatures ranging from 25 to 30 °C. However, the species has established populations in temperate regions in both hemispheres, where thermal regimes include periods of much colder conditions. Several hypotheses have been put forward to explain the ability of guppies to thrive outside the tropics. They could be thermal generalists or be extremely plastic in their response to changes in temperature.
Methods: In order to explore these questions, we tested thermal performance of key life history traits such as juvenile growth, age and size and maturity, reproductive allotment and explored some of the classic trade-off between size and number of offspring or current vs. future reproduction. Laboratory experiments under different simulated thermal regimes provided insights of what would happen under several hypothetical scenarios.
Results: Size at birth and at maturity were smaller at high temperatures. Growth trajectories for males and females were also affected by thermal regime both during embryonic development and juvenile stages. Gestation time, or interval between broods was shorter at warmer temperatures, although highly variable and female size partially explained this variation.
Conclusion: Our results indicate that guppies can perform at a wide range of temperatures and also display phenotypic plasticity in their thermal performance. This phenotypic and developmental plasticity in ecologically important life history traits can be what makes a tropical species able to invade temperate regions.

O43-05 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Putting transdisciplinary research into practice: a participatory approach to understanding change in tropical social-ecological systems

CLAUDIA BENHAM[1], SARA BEAVIS[1], EMMA JACKSON[2]
[1]The Australian National University, Fenner School of Environment and Society, 2600, Canberra, Australia
[2]CQUniversity, School of Medical and Applied Science, 4680, Gladstone, Australia

As tropical ecosystems undergo increasingly rapid change, there is an urgent need for research that transcends academic disciplines and can respond to complex environmental problems. While the benefits of transdisciplinary research are widely recognised, challenges arise in putting these approaches into practice. This paper outlines a participatory research approach used to scope and conduct a programme of ecological and social research in the Great Barrier Reef, Australia. The research demonstrates that incorporating participatory techniques during the research scoping phase can help researchers to develop a transdisciplinary research programme that can both strengthen ecological research outcomes and ensure their relevance to tropical communities and decision makers.

O43-06 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

'Conservation' versus clearance: Land-use conflicts in North eastern Thailand

JAMES MOLONEY[1], WASSANA PHANURAK[2], NETCHANOK KHONGTHON[2], CHANG NIGEL[3]
[1]James Cook University, C.M.E.S., 4811, Townsville, Australia
[2]Nakhon Ratchasima Rajhabhat University, Geography, 30000, Nakhon Ratchasima, Thailand
[3]James Cook University, C.A.S.E., 4811, Townsville, Australia

North-eastern Thailand has been heavily-cleared over the last 50 years with the expansion of rice growing and, more recently, clearing of drier areas for cassava and other crops. This has led to a loss of biodiversity, and impacts on traditional natural resource use. Although many local communities maintain community forests as a means to continue the harvest of plants and animals, sustainability is uncertain.
In this study, we investigate the impacts of broad-scale cropping on vertebrate biodiversity and traditional resource use in Nakhon Ratchasima province, North eastern Thailand. The overall project comprised three parts. 1. We quantified regional landscape change from the 1950s until the present from a combination of aerial photography and satellite image analysis, and examined environmental correlates. 2. Bird, mammal and reptile assemblages were examined across five different land-cover types using active searching (reptiles), point-counts (birds) and a combination of opportunistic recording and formal and informal interviews with local people (mammals). 3. Social surveys including formal and informal interviews and participatory mapping address questions of who uses the community forests, how they use them, where users come from, and what forms of governance exist to manage the forests.
We found that significant areas of the original closed forest on floodplains had already been cleared by the 1950s. The last 35 years has seen increased clearance of woodland in drier areas as crops diversify. The most intact forest type is low woodland, which in some cases is under community forest protection. However, within these areas, bird and mammal assemblages are less diverse than within other woodland and forest types. In particular, the dry-season diversity of insectivorous birds and evergreen forest species as well as mammals is low within this more secure forest in comparison to outside, unprotected areas. Furthermore, many of the traditional resources important to local people are found within unprotected and fast-disappearing areas.
In North eastern Thailand, both biodiversity and traditional resource use are impacted by the broad clearing of natural vegetation for crops. While there is the possibility of land swaps and purchases to maintain ecosystem services, more coordinated planning is required to maintain a variety of forest types and the diversity that they contain.

O43-07 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Plant Usages of Lowland and Lawa Populations in Phu Fah Subdistrict, Bo Klua District, Nan Province, Thailand

APICHART SONGSANGCHUN, ANGKHANA INTA, PRASIT WANGPAKAPATTANAWONG
Chiang Mai University, Biology, 50200, Chiang Mai, Thailand

Traditional plants-use study of native and lawa populations in Phu Fah subdistrict, Bo Klua district, Nan province, was conducted to investigate the traditional usage of plants for their daily life. The study was done by surveying and interviewing key informants for common names of plants, and used parts and their benefits. The collected specimens were identified for their scientific names and made into herbarium specimens. The indigenous plants usage were surveyed from four villages, namely, Ban Hang Tang Luang, Ban Pha Suk, Ban Huay Lom and Ban Huay Loy. The former two were native and the latter two were lawa. There was the total of 585 plant species in 347 genera and 131 families. They were classified into 448 species of dicotyledon, 121 species of monocotyledon, 14 species of pteridophyte and 2 species of gymnosperm, and classified into 8 groups according to their usage as food plants (330 species), animal food plants (14 species), medicinal plants (180 species), housing-material plants (109 species), utensils plants (73 species), spiritual ceremony plants (9 species), vertebrate-poison plants (4 species) and ornamental plants (18 species). Quantitative study showed that cognitive uses of the plants increased with the age. And people who have been formally educated had less knowledge of plant-use than the people who do not receive formal education. Some interesting plants were Inula cappa (Ham. Ex D.Don) DC., which was used as a medicine for several symptoms, e.g. pain, inflammation, flu and restorative. Cyperus trialatus (Boeck.) Kern. was used for weaving appliances. Tristaniopsis burmanica var. rufescens (Hance) J.Parn.&NicLugh. was used as charcoals. The data from this study can be used to find ways for conservation and continuing the folk wisdom.

O43-08 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Biodiversity of Long Lellang and Sustainability of Borneo Indigenous Community Initiative by the Nature Appreciation Rainforest School, Sarawak, Malaysia

PEI-LUEN LU[1], LI-PENG HSU[1], SANDRA LING HIE WONG[2], BIH SHYA YONG[2], JONG YIAW CHANG[2]
[1]Da-Yeh University, Bioresources, 51591, Changhua, Taiwan
[2]SOW Culture & Nature Appreciation Rainforest School -CNAS, Nature Education, 93300, Kuching, Sarawak, Malaysia

Tropical rainforests are very important for the earth sustainability and play an essential role for biodiversity. The entire Borneo has fewer 5% native forests of the total areas according to the latest official investigation. Long Lalleng rainforest is one of those rare native forests in Borneo. No previous research is available. The indigenous people Penan live in this forest and the other indigenous people Klabit live one the edges of the forest and live with agriculture. Unfortunately, logging companies intended to invade Long Lalleng, Sarawak. The SOW Culture & Nature Appreciation Rainforest School is one of the only two legal NGO organizations in Sarawak, Malaysia and they establish this foundation mainly for rainforest conservation. We cooperate with SOW Rainforest School and indigenous people to do a pioneer biodiversity survey in the Long Lellang rainforest from July 2015 to February 2016. In this study, we will present the update biodiversity information. In addition, this study provides a successful and peaceful example of land protection and conservation for all indigenous people and for the other types of communities. Female and males both carry on important roles in these communities. We observe traditional knowledge pass into next generations more effectively and even pass into outside new bloods due to this long-term conservation effort. The consequences helps not only local people' economic development but also help government business. This case also shows this alternative methodology can still improve development. Most stakeholders and indigenous groups are benefited from multiple solutions. This way can allow proper development from the ecotourism, traditional knowledge, and sustainable agriculture. That is truly equality and respect for those people and environments. The other significant meaning is to keep rainforests alive. We have known that the serious deforestation often not only damaged the whole ecosystem but also usually invade indigenous homelands. During this conflict between developments and conservations, national and local governments frequently cannot provide good solutions. Therefore, this special example should be a great idea to address in the ATBC2016. This study keeps going on and extends into a long-term ecology and biodiversity study in this area.

O43-09 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Disturbance or propagule pressure? Unraveling the drivers of the invasion of free-ranging dogs in Atlantic forest landscapes

FERNANDO RIBEIRO[1], LIZ NICHOLS[2], RONALDO MORATO[3], RENATA PARDINI[1]
1Universidade de São Paulo, Instituto de Biociências, 05508090, São Paulo, Brazil
[2]Swarthmore College, Department of Biology, 19081, Swarthmore Pennsylvania, USA
[3]ICMBio, Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros, 12950011, Atibaia, Brazil

Background: Biological invasions are currently the second main threat to biodiversity. However, the importance and synergies of different drivers for the success of invasions are still debated. Dogs are the most abundant carnivores worldwide and are predominantly free ranging in rural areas, creating extensive opportunities to interact with and affect native species through predation, disease transmission and competition. Using a camera trap dataset and censuses of dog populations obtained across a 300,000-ha Atlantic forest region, we evaluated the relative importance and interaction of propagule pressure and disturbance as drivers of dog invasion.
Methods: We selected 12 2830-ha landscapes, ranging from 10 to 48% remaining forest. Within each, we selected 8 forest sites using a random-stratified sampling, and set 1 camera trap in each for 42 consecutive days. All households in each landscape were visited to count the number of dogs. Propagule pressure was quantified as dog density, and mean and median distances between locations where dogs were raised and the nearest forest. Habitat disturbance was quantified as native forest and total (native + exotic) forest cover, and edge extension between native forest and open areas. By identifying individual dogs in the photos, and considering 7 6-day sampling sessions and each landscape as a sampling unit, we compared through AICc N-mixture models to estimate dog abundance in forests, considering imperfect detection. The candidate models included abundance constant, as a function of each of the 6 variables, or as an additive or interactive function of all possible combinations of 2 variables, one of each group (propagule pressure and disturbance).
Results: The only selected model indicates that dog abundance in forests is higher in landscapes where the density of dogs is higher and total forest cover is lower (ωi=0.82). Estimated dog abundance in forests varied from 12 to 79 (30.9±19.5), and the proportion of raised dogs that invade forests from 6 to 29% (12±6%), across landscapes.
Conclusion: Habitat loss is as important as propagule pressure in driving the invasion of dogs in forests. Beyond the traditional population control, landscape context should be taken into account within strategies to reduce impacts of dogs. Highly-deforested landscapes should be prioritized given that invasion in this case can be more intense even if the population of dogs is smaller, probably because forest loss facilitate dog movement.

O43-10 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

How do indigenous hunters of the Colombian Amazon resolve trade-offs between conservation and development?

NICOLE PONTA[1], NATHALIE VAN VLIET[2], MARIA PAULA QUICENO MESA[3], CLAUDE GARCIA[4]
[1]ETH Zurich, Environmental Systems Science, 8092, Zurich, Switzerland
[2]CIFOR, Bushmeat Research Initiative, 16115, Bogor, Indonesia
[3]Fundación Science International, Forests, wildlife and nutrition, 110311, Bogotá, Colombia
[4]CIRAD, Tropical Forests Goods and Ecosystem Services, 34398, Montpellier, France

Understanding the forces that drive decision-making by stakeholders is a crucial aspect in developing successful strategies for natural resource management. Empirical knowledge is only one of these drivers, as practices are also decided by individuals' beliefs, perceptions and interests, by the assets available and the institutions and norms dictating what is acceptable. Uncovering the underlying reasons for individual management decisions thus requires integrated approaches, and is particularly relevant to ensure the engagement of local communities and the effective implementation of community-based initiatives.
Throughout the Colombian Amazon communities carry out subsistence as well as small-scale commercial bushmeat hunting. Overharvesting, together with habitat loss, poses a dual threat to biodiversity and to the people who depend on it for food and income: the hunters and their families. Having empirical knowledge and being aware of the high stakes if the resource crashes, hunters might have developed effective strategies for game management. Given this, we wanted to explore how hunters perceive and handle the well-known trade-off between biodiversity conservation and socio-economic development, particularly in the context of the Ticoya indigenous reserve in the Colombian Amazon.
To this end, we used ReHab, a role-playing game that revolves around the management of a renewable resource. Players are either Harvesters that need to feed their families using the resource, or Park Managers seeking to protect a migratory bird sensitive to resource level and human disturbance. ReHab allows players to explore the concepts of natural resource management and sustainability when dealing with conflicting agendas and partial knowledge. The game has been played in multiple occasions in different contexts, creating a benchmark against which to compare sessions played within the culturally homogeneous group of the Ticoya hunters. We found a positive effect of communication and monitoring on the outcome indicators of conservation and development measured during the game sessions. Incomplete information and the lack of enforcement power did not prevent players to successfully resolve the trade-off and satisfy their contrasting agendas. Acknowledging the gains and losses imbedded in the decision-making process results in better designed and more resilient co-management strategies that take into account the individual and local communities' perceptions and expectations.

O43-11 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

What affects the occurrence of the golden-headed lion tamarin, Leontopithecus chrysomelas, in Brazilian cocoa agroforests?

JULIANA M DE ALMEIDA ROCHA[1], JULIO AB MONSALVO[2], LEONARDO C OLIVEIRA[3]
[1]Universidade Estadual de Santa Cruz, Programa de Pós-Graduação em Ecologia e Conservação da Biodiversidade, 45662-900, Ilhéus, Brazil
[2]Universidade Presbiteriana Mackenzie, Centro de Ciências Biológicas e da Saúde, 01302-907, São Paulo, Brazil
[3]Universidade Estadual do Rio de Janeiro, Faculdade de Formação de Professores, 24435-005, Rio de Janeiro, Brazil

The occurrence of a species in different habitats may depend on factors such as those related to climate, vegetation structure and ecological interactions. The golden-headed lion tamarin (GHLT), Leontopithecus chrysomelas, is an endangered primate from Brazillian Atlantic Forest. The most preserved part of its range is currently dominated by shaded cocoa agroforest (cabruca), which makes urgent to understand what affects its occurrence in this habitat to ensure its conservation. Cabrucas can sustain a high faunal biodiversity despite being structurally simplified in comparison to forests, but the intensification of management by decreasing the shading tree density is a threat to such biodiversity. GHLTs can survive and reproduce in this habitat, otherwise exposed to a high predation risk (predator-prey encounter rates) mainly by raptors. We investigated the role of predators and vegetation structure for the presence and density of GHLTs in cabruca. The following sampling methods were applied in 16 cabrucas within the species' range, in South Bahia, Brazil: playback and active search for GHLTs, camera traps for terrestrial predators and a combination of active search, playback and point counts for aerial predators. Seven plots of 200m² were established in each area to characterize the vegetation (e.g. connectivity, the number and density of trees, and other variables). The GHLT was recorded in 10 of 16 cabrucas and a total of seven species of carnivores (three potential predators) and 23 raptors (13 potential predators) were recorded in all areas. Linear generalized models revealed a positive correlation between the presence of GHLTs and height/connectivity of trees and between the density of GHLTs and vine density. Although predators seem not decisive for the GHLT's occurrence in this habitat, a positive correlation between raptors' diversity and height/connectivity of trees may explain the high predation risk in cabruca. GHLTs and raptors seem to choose similar places to use in this habitat and the consequences of this on future mortality rates due to predation remains unknown. The occurrence and density of the GHLT in cabruca seems to be better explained by vegetation structural complexity so that the intensification of management in plantations poses another threat for GHLTs.

O43-12 – S43 *Free session: Human-nature interactions in tropical landscapes*
Wednesday 22 June / 08:30-12:00 – Antigone1

Agrarian Change in Tropical Landscapes – A Change for the Better?

TERENCE SUNDERLAND
CIFOR, SLF, 16000, Bogor, Indonesia

Agricultural expansion has transformed and fragmented forest habitats at alarming rates across the globe, but particularly so in tropical landscapes. The resulting land-use configurations encompass varying mosaics of tree cover, human settlements and agricultural land units. Meanwhile, global demand for agricultural commodities is at unprecedented levels. The need to feed nine billion people by 2050 in a world of changing food demands is causing increasing agricultural intensification. As such, market-orientated production systems are now increasingly replacing traditional farming practices, but at what cost?
Focusing on seven multi-functional landscapes in Ethiopia, Cameroon, Indonesia, Nicaragua, Bangladesh, this paper will present various scenarios of changing forest cover, agricultural modification and integration with local and global commodity markets. We examine responses to agrarian change processes at household, farm, village and landscape levels with a focus on poverty levels, food security, dietary diversity and nutrition, agricultural yields, biodiversity, migration and land tenure. This research provides much needed insights into how landscape-scale land-use trajectories manifest in local communities and advance our understanding of multi-functional landscapes as socio-ecological systems.

O44-01 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

A spatially explicit model of natural regeneration potential: a case study from the Piracicaba River Basin, Brazil

ROBIN CHAZDON[1], PAULO GUILHERME MOLIN[2], PEDRO H. S. BRANCALION[2]
[1]University of Connecticut, Ecology & Evol. Biology, 06269-3043, Storrs, CT, USA
[2]USP/ESALQ, Depto. de Ciências Florestais, 13.418-900, Piracicaba-SP, Brazil

Background: Widespread environmental degradation has increased the interest in science and practice of forest restoration. Although investment in forest restoration is proven financially viable for the environmental and ecological benefits being provided, financial resources to pay for restoration are limited, particularly in developing countries, such as Brazil. There is an urgent need to optimize financial resources to enable successful interventions on a large scale. To address this need, we develop a spatially explicit landscape model to examine the role of selected biophysical and socioeconomic factors as predictors of forest regeneration in the Piracicaba river basin (12,500 km^2) in the Southeastern Atlantic Forest Region of Brazil.
Methods: Two land cover maps dated 2000 and 2010, elaborated from Landsat 5 TM images, were used. Three landscape units (LU) were selected for analysis; one with predominant sugarcane plantations, 7.4% native forest cover and low mean slopes (LU1); another with predominant native forest cover (44.2%), followed by pasture land and higher mean slopes (LU2); and a third with a more even distribution between pasture land (34.3%), native forest (27.6%) and sugarcane plantations (19.3%; LU3). We selected six biophysical and six socioeconomic independent variables for Weights of Evidence (WofE) analysis, using Dinamica EGO software. WofE contrast values were calculated for transitions from agriculture and pastureland into naturally regenerating forest, thus resulting in an importance value for each variable for different ranges, along with spatial explicit probability maps for regeneration potential.
Results: Natural regeneration is influenced by multiple biophysical drivers, which may differ in importance in each LU. Regeneration in agricultural land cover was identified as more probable when slope was above 18%, especially in LU1 and LU3. Probabilities also increased when distance to water bodies was below 120 m, in all LU, for both pasture and agricultural land covers. Distance to previous native forest also increased probabilities for both transitions, in all LU, when below 80 m.
Discussion: Biophysical drivers are the predominant spatial determinants of forest regeneration. Some drivers, such as slope, varied in importance across different LUs. We use these results to predict cost-effectiveness of passive and active forest restoration within this region of Brazil.

O44-02 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Secondary succession in forests of central Borneo: a 19-year record

FRANCIS BREARLEY
Manchester Metropolitan University, School of Science and the Environment, M1 5GD, Manchester, UK

Background: Secondary forests now form an increasing proportion of all forests worldwide and understanding their structure, diversity and dynamics is important from the view of conservation, carbon sequestration and numerous other ecosystem services.
Methods: We followed the course of succession in secondary forests from 3 to 40 years of age over a < 19 year period in permanent plots in central Indonesian Borneo. Tree diversity and biomass were recorded along with soil chemistry.
Results: Forest biomass and species richness increased over time as anticipated. There were indications of alternative successional pathways dependent upon the number of prior cultivation cycles. Recovery of dipterocarps (dominant in primary forest) was very slow. Soil carbon stocks increased along with changes in soil organic matter chemistry.
Conclusions: Secondary succession is an important process that can contribute to providing ecosystem services when population densities are low. There are suggestions that succession may be slower in South-east Asia than the better-studied Neotropics but this needs further work.

O44-03 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Bird community development in the canopy and understorey of Neotropical secondary forest.

TOM BRADFER-LAWRENCE, DAISY DENT
University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, United Kingdom

Background: There are enormous changes taking place in tropical ecosystems. Ongoing destruction of old-growth forest has the potential to cause mass species extinctions, and secondary forest now accounts for over half the forest cover in the tropics. Secondary habitats are increasingly recognised for their potential for biodiversity conservation, but there are still many questions regarding the rate, direction and extent of faunal community development. Are secondary forests able to function as refugia for vulnerable species?
Methods: This study was undertaken in a chronosequence of secondary forests in central Panama, at sites of 60, 90 and 120 years old, and old-growth forest. Previous research examining birds in this context has been exclusively ground-based, and hence is biased towards species in lower levels of the forest. We employed a novel method; undertaking simultaneous bird surveys from both the canopy and the understorey.
Results: Bird community development varied according to both habitat age and level of isolation, but these effects were stronger in the understorey compared to the canopy. Guild proportions and body mass patterns did not appear to change with habitat age, but were significantly different among strata. Compared with the understorey community, the canopy community is characterised by higher species diversity, and greater variation in dietary breadth and body size.
Discussion: By giving equal attention to all forest strata these findings provide a more nuanced picture than previous, ground-based research. The results highlight that secondary forests may offer critical refugia for many bird species, particularly specialist canopy-dwellers. However, the understorey bird community is less adaptable to novel habitats due to lower dispersal abilities and greater dietary specialisation. These findings contribute to the growing understanding of the factors influencing bird colonisation and community assembly in secondary forest. Understorey bird community species ought to be the focus of conservation efforts to encourage colonisation of secondary forests.
I wish to be considered for the Alwyn Gentry Award.

O44-04 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Characterising avian communities across a successional gradient in regenerating tropical forests of Central Panama

REBEKAH J. MAYHEW[1], JOSEPH A. TOBIAS[2], DAISY H. DENT[1]
[1]University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, UK
[2]Imperial College London, Department of Life Sciences, SL5 7PY, Ascot, UK

Background: Deforestation and degradation of tropical old-growth forest has the potential to cause mass species extinctions. Expansion of regenerating secondary forest may mitigate the loss of old-growth forest but the role that secondary forest can play in the conservation of old-growth forest species hinges on whether these forest ecosystems can maintain similar species composition and function as old-growth forest. Birds are among the most well studied faunal groups in the tropics and are often used for studies examining responses to tropical forest changes. Previous studies have found conflicting results as to the value of secondary forest for bird species. However, the vast majority have only looked at young, single-aged secondary forest, with almost no consideration of older secondary forest. Thus there is a likelihood of critically underestimating the future value of secondary forest.
Methods: This study was undertaken in the Barro Colorado Nature Monument, Soberania National Park and Agua Salud Project in central Panama. This area is a mosaic of tropical old-growth and secondary forest, covering island, peninsula and mainland sites. Point counts were used to compare the bird communities in 20, 40, 60, 90 and 120-year-old secondary forest, as well as old-growth forest stands. This chronosequence is far longer than other studies published to date. We examine patterns of species diversity, dominance, and community composition to evaluate the conservation value of regenerating tropical forest, adding a greater temporal analysis than has been previously possible.
Results: Species richness values in all ages of secondary forest are similar to those of old-growth forest, although the highest levels of species richness and diversity are found in the youngest forest sites. Patterns in species diversity and dominance appear to be driven by the impacts of isolation rather than forest age. Both forest age and isolation have significant effects on the community structure.
Conclusion: Secondary forests have a vital role to play in the conservation of tropical species. Even young habitats can support large numbers of bird species, including species traditionally considered forest specialists. Only by examining such a wide chronosequence was it possible to provide such fine-scale detail of bird community development in regenerating forest. This work will help to inform conservation policy and management.

O44-05 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Performance of eight years old restoration plantings at a Mexican tropical dry forest

CRISTINA MARTÍNEZ-GARZA, MARCELA OSORIO-BERISTAIN, RAÚL ALCALÁ MARTÍNEZ, DAVID VALENZUELA-GALVÁN
Universidad Autónoma del Estado de Morelos, CIByC, 62209, Cuernavaca, Mexico

Background. The success of plantings, a maximal restoration intervention to recover ecosystem structure and function, depends on the performance of selected tree species. Tree species can be selected by their good performance in the degraded areas or because they may cover different ecosystem functions; for example some species having fleshy fruits feed frugivores, tall tree species may provide perches for birds and others develop a large canopy cover to depress exotic grasses.
Methods. In August 2006, 20 native tree species were planted in mixed stands in 4 50 X 50 m fenced plots in a secondary dry tropical forest of the state of Morelos, Mexico. Two tree species are considered early successionals and 18 late-successionals species; nine species have fleshy fruits dispersed by animals and 11 species have dry fruits dispersed by wind or gravity.
Results and Discussion. After eight years, the early successional tree with fleshy fruits, Bursera grandifolia (Burseraceae) showed the lowest survival percentage (5 %) and the late-successional tree dispersed by gravity or accidentally by animals Erythrina americana (Fabaceae) showed the highest survival (70 %). All individuals of Mastichodendron capiri (Sapotaceae) and Enterolobium cyclocarpum (Fabaceae), both of them late-successional with fleshy fruits, died. Bursera grandifolia showed the highest relative growth rates (RGR) in height (36.97%) and in diameter at the base (32.01 %) whereas the late-successional tree with fleshy fruit Cresentia alata (Bignoniaceae) showed the lowest RGR in height (9.28 %) and in diameter at the base (9.09 %). Tree species dispersed by animals had similar survival, RGR in height and in diameter than those dispersed by wind. Erythrina americana showed the highest integrated performance index (survival X RGR height X RGR diameter). The late-successional tree with fleshy fruits Jacaratia mexicana (Caricaceae) reached 2.9 m height whereas Bursera aloexylon (Burseraceae) developed the largest canopy cover (18.07 m2).
Conclusions. Important ecosystem functions to accelerate natural succession, as attraction of dispersers or provision of canopy cover are not delivered by the same tree species. Planting as many tree species as possible assures that many ecosystem function be covered in restored sites.

O44-06 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Factors affecting seed rain under remnant pasture trees: A Pan-Tropical study

LACHLAN S. CHARLES[1], HAZEL M. CHAPMAN[2,3], RICHARD A. FULLER[1], JOHN M. DWYER[1,4], MARGARET M. MAYFIELD[1]
[1]School of Biological Sciences, University of Queensland, Brisbane 4072, Australia
[2]Centre for Integrative Ecology, School of Biological Sciences, University of Canterbury, Christchurch, New Zealand
[3]Nigerian Montane Forest Project, Yelwa, Taraba State, Nigeria
[4]CSIRO Land and Water Flagship, Ecosciences Precinct, Dutton Park, Brisbane, Australia

Remnant trees in tropical pastures are often considered important for natural rainforest regeneration by attracting forest seed dispersing birds into species poor pastures. Despite a general acknowledgement that such trees likely play in natural rainforest regeneration throughout the tropics, there are contrasting opinions about which characteristics of remnant pasture trees, or their geographical position in a landscape influence avian visitation and seed deposition patterns. This debate may arise because of innate differences between tropical regions or simply because studies that have assessed the "value" of remnant pasture trees for attracting avian seed dispersers have historically varied widely in approach and methodology. With the majority of research on remnant trees occurring in the neo-tropics, identical comparative studies within other tropical regions are needed to gain a better understanding of how these trees can influence successional trajectories within tropical countryside landscapes more generally. Here we present results from a replicated pan-tropical experiment, in which seed rain was collected from under 144 remnant trees across three tropical and one sub-tropical region of Australia, Colombia and Nigeria. In order to determine the effects of tree and landscape characteristics on bird dropped seed under remnant pasture trees we related a variety of consistently measured tree structural attributes (including tree height, canopy cover, crown diameter and fruiting phenology) and several landscape structural features to the richness and abundance of seed dropped under large remnant trees found in three different tropical landscapes in each study region. Results suggest that there are regional differences in the importance of landscape structure on seed drop under isolated tropical pasture trees but that tree architecture may be more generally important across tropical regions. This comparative study provides essential information about the potential importance of remnant trees in tropical pastures to rainforest regeneration across the tropics.

O44-07 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Adapting Inga-based agroforest to the Bolivian Amazon

ALEX MONRO[1], ROLMAN VELARDE OSHIRU[2], VICTOR SORUCO[2], JUAN FERNANDO REYES[2], LUCY DABLIN[3], WILLIAM MILLIKEN[1]
[1]Royal Botanic Gardens, Kew, Science, TW9 3AE, Richmond, UK
[2]Herencia, Agroforesteria, Calle Civica, Cobija, Bolivia
[3]University College London, Faculty of Life Sciences, WC1E 6BT London, UK

Agroforest has been promoted as an agricultural tool in the tropics since the 1970s and the International Council for Research in Agroforestry (ICRAF), established in 1978, continues to promote this approach today. Outside of coffee and cacao, however, agroforest is not being widely applied to meet the agricultural needs of Latin America. We believe that this may be to do with the way in which agroforestry has been introduced to rural communities and that barriers to the uptake of agroforest in rural communities in Latin America include the absence of land tenureship, that agroforest does meet a perceived development need, and that establishing agroforest systems entails high levels of risk for poor rural communities who depend on agriculture for their and their families well-being. This poster outlines an integrated approach to applying agroforest to rehabilitate degraded agricultural land in the Bolivian Amazon funded by the Darwin Initiative and the innocent foundation and led by the Royal Botanic Gardens, Kew. The Amazon includes ca 30 million ha of marginal / abandoned agricultural land (Dias-Filho, 2011). The aim of this work is to rehabilitate degraded land and so reduce the demand for deforestation as well as improve livelihoods and nutrition for lower income rural communities. We aim to do so by mitigating the barriers identified above. That is, we develop agroforest as part of a broad community development plan that aims to integrate a range of social and economic needs, we work with communities who have tenureship of their land, we bear the risks associated with initial establishment and failure, as far as possible integrate agroforest establishment into children's educational activities, notably the 'bosque de los niños' initiative and we monitor monitor engagement in a participative manner.

O44-08 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Evaluating novel species mixtures in a functional trait-based restoration experiment

REBECCA OSTERTAG[1], NICOLE DIMANNO[1], LAURA WARMAN[2], SUSAN CORDELL[2], AMANDA UOWOLO[2], JODIE SCHULTEN[1], TAITE WINTHERS-BARCELONA[1], PETER VITOUSEK[3]
[1]University of Hawaii at Hilo, Department of Biology, 96720, Hilo, USA
[2]Institute of Pacific Islands Forestry, USDA Forest Service, 96720, Hilo, USA
[3]Stanford University, Department of Biology, 94305, Stanford, USA

Background: Restoration to a previous condition may not be feasible in all situations, due to a lack of information, invasive species, or climate change. When site improvement is desirable, a valuable option is restoration based on functional traits. However, the concept requires experimentation in order to understand the role of functional diversity at a given site. We conducted a restoration experiment in a lowland wet forest in Hawai'i, employing both native and exotic (non-native but non-invasive) species with varying functional trait expression in experimental treatments. This experiment tests whether greater invasion resistance, carbon sequestration, and native species regeneration occur under combinations of species whose traits are more dissimilar (complementary) or similar (redundant).
Methods: Sixteen plots arranged in 4 blocks with similar vegetation structure, light levels, and soil nutrients were cleared of all non-native species, while four additional ones were left uncleared as reference plots. The treatments consisted of different sets of ten planted species in addition to the existing native trees that varied in the rate of C cycling and in the range of functional trait expression (Slow Redundant, Slow Complementary, Moderate Redundant, Moderant Complementary). This study represents one of the few community assembly experiments in a complex forest ecosystem.
Results: Native species recruited into all four treatments, but not into reference plots. After approximately 1.5 years, overall survival of outplants was high (87.6%). The two Redundant treatments had the best survival, though the Slow Redundant treatment had the lowest growth, suggesting a potential tradeoff between growth and survival. Decomposition rates of mixed litter was highest in the Moderate Complementary treatment, but the other three treatments were not different.
Discussion: In these forests higher rates of nutrient cycling are disadvantageous because they are more likely to foster the establishment and growth of highly invasive species. The Slow Complementary treatment may be the best hybrid community to meet our highest priority of creating a canopy that provides invasion resistance.

O44-09 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Direct seeding and planting of seedlings in secondary forests: the roles of dispersal and recruitment limitations

ANA PALMA, MIRIAM GOOSEM, SUSAN LAURANCE
James Cook University, Centre for Tropical Environmental and Sustainability Science (TESS) and College of Marine and Environmental Sciences, 4878, Cairns, Australia

Background: Dispersal and recruitment limitations are crucial processes shaping forest composition. In secondary forests these mechanisms may operate differently than in mature forests, because early-aged and isolated secondary forests may suffer stronger limitations due to a lack of suitable dispersers and harsh environmental conditions.
Methods: To assess dispersal and recruitment limitations in these forests, we used experiments involving direct seeding and planting of seedlings in a chronosequence of secondary forests in tropical Australia. Six rainforest tree species were selected based on previous information regarding the species composition of secondary and mature forest sites in the region. Our direct seeding experiments included three large-seeded (> 20 mm in length) rainforest tree species that were absent from our regenerating forest but present in mature forest sites in the region; and two small-seeded (< 15mm in length) rainforest tree species that are present in both secondary and mature forest sites in the region. Our planting experiment included an additional small-seeded late successional species present in both secondary and mature forest sites in the region. Our direct seeding experiment (5 spp) included three treatments: 1) exposed seeds, 2) fenced seeds and 3) buried seeds. This study encompasses 12 secondary forest sites ranging from 4 to 34 years since canopy formation. Forest age categories used: Young: 4 to 12 years; Intermediate: 16 to 20 years; and Old: 23 to 34 years, we included 4 sites for each age category.
Results: After 14-17 months, all species germinated in all secondary forests, however in young secondary forest sites fewer seeds survived. In all age categories, greatest survival rates were observed when seeds were buried (27.25%), contrasting with the low survival of exposed seeds (6%). Planted seedlings had greater survival (63.08%) and higher growth rates in old secondary forests (27.39% more than in intermediate-aged and 9.58% more than in young forest sites). We found that species identity is important for growth and survival in both experiments, but we detected no effect of successional status or seed size.
Conclusion: As all species germinated irrespective of variation in site conditions, we conclude that dispersal limitation is a greater barrier to recovery of secondary forests in the region than the recruitment limitations imposed by environmental conditions experienced during our experiment.

O44-10 – S44 *Free session: Secondary forest succession and restoration*
Wednesday 22 June / 14:30-17:30 – Antigone1

Using plant functional traits and soil amendments to restore degraded vertisol soils in a tropical dry forest

LELAND WERDEN[1], JENNIFER POWERS[2]
[1]University of Minnesota, Plant Biological Sciences Graduate Program, 55108, St. Paul, MN, USA
[2]University of Minnesota, Ecology, Evolution, and Behavior, 55108, St. Paul, MN, USA

Background: Tropical dry forests (TDFs) are one of the most endangered ecosystems in the world, and large-scale restoration efforts in northwestern Costa Rica have been implemented to catalyze TDF regeneration. Passive restoration techniques have been widely implemented but are not effective on all soils, such as heavily degraded Vertisols, which are soils with high expansive clay content that were previously used for grazing and rice cropping in our region, and are common in the seasonally dry tropics.
Methods: In order to better understand how to facilitate degraded vertisol restoration, we completed a large-scale field trial in in northwestern Costa Rica to determine (1) if inexpensive and readily available soil amendments increase overall survival rates of planted seedlings, and (2) to examine how aboveground plant traits influence the performance of 32 tree species planted in degraded vertisol soils. In 2014 we planted 1,800 seedlings of 32 tree species into six blocks with these treatments: amendments (sand, rice hulls, burned rice hulls, or water retaining gel), or unamended controls. For each of these species we quantified a suite of aboveground functional traits.
Results: To determine the effect soil amendments had on the overall survival of planted seedlings, we built a logistic regression model with planted seedling survival at the conclusion of the wet season as the response, and amendment in each treatment block as the predictor. Our analysis showed that both the gel and sand treatments significantly increased the predicted survival of planted seedlings by up to 10% when compared to the controls by modifying microclimatic conditions. Additionally, we found that tree species able to increase water use efficiency (based on 13-C foliar isotope data) after planting were significantly more likely to survive for the first year.
Conclusion: Results from this study will help to determine best practices for the amelioration of degraded vertisols throughout the region, and were used when establishing 6-hectares of restoration plantings in Costa Rica in 2015.

O45-01 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Comparative niche modeling of bush-shrikes along an elevational gradient highlights the plight of mid-elevation forests

FABIO BERZAGHI[1, 2], JOHN BATES[1], FABIO BERZAGHI[2], JOSH ENGEL[1], ANDREW PLUMPTRE[3]
[1]Field Museum of Natural History, Bird Division, 60605, Chicago, USA
[2]University of Tuscia, aDepartment for Innovation in Biological, Agro-food, and Forestry Systems, 01100, Viterbo, Italy
[3]Wildlife Conservation Society, Uganda Country Office, 7487, Kampala, Uganda

Montane forests harbor some of the highest numbers of endemic flora and fauna in Africa. We present results of species distribution models of two Albertine Rift endemic bush-shrikes (Laniarius) that until recently had been classified as one species. We created distribution maps based on presence-only data gathered from museum specimens and combined them with data from field surveys from the region. Niche models, driven by environmental variables and competing models, were evaluated based on different statistical measures and according to an intuitive and broadly applicable model-selection methodology. Our models document that the recently described Willard's Sooty Boubou (Laniarius willardi) has lost most of its potential habitat and it is highly endangered compared to Mountain Sooty Boubou (Laniarius poensis). L. poensis occurs above 2000 m in highland forests that are more intact and better protected than mid-elevation forests where L. willardi occurs. This elevational replacement highlights the plight not only of a newly described species, but also that of all biodiversity in mid-elevation forests in the Albertine Rift region and in similar Afro-montane tropical regions.

O45-02 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Benefits of remotely sensed data for biodiversity mapping along an elevational gradient in a mountain rainforest system

NINA FARWIG[1], CHRISTINE WALLIS[1], YVONNE TIEDE[1], DAVID DONOSO[2], DETLEV PAULSCH3, KONRAD FIEDLER[4], GUNNAR BREHM[5], DIRK SÜSSENBACH[6], JÜRGEN HOMEIER[7], ROLAND BRANDL[8], JÖRG BENDIX[9]
[1]Marburg University, Conservation Ecology, 35032, Marburg, Germany
[2]University of Cuenca, Agriculture, Cuenca, Ecuador
[3]Gesellschaft für angewandte Ökologie und Umweltplanung mbH, 69190, Walldorf, Germany
[4]University of Vienna, Tropical Ecology and Animal Biodiversity, 1030, Vienna, Austria
[5]Inst. für Spezielle Zoologie und Evolutionsbiologie mit Phyletischem Museum, 7743, Jena, Germany
[6]Federal Environment Agency, 6844, Dessau-Rohlau, Germany
[7]Göttingen University, Plant Ecology, Göttingen, Germany
[8]Marburg University, Animal Ecology, 35032, Marburg, Germany
[9]Marburg University, LCRS, 35032, Marburg, Germany

Information derived from various remote sensing sources provides surrogates for habitat structure and therefore information to model the occurrence respectively abundance of flagship species as well as the diversity of species assemblages across space. Such information is often of basic importance for conservation planning, particularly as limited field data are available. However, the spatial predictability of species richness or other measures of α-diversity is often poor. Additionally, species richness and other measures of α-diversity ignore information of species identity, which is at least in part covered by measures of β-diversity. Various studies have shown that the change in the composition of communities across space is closely related to spatial changes in habitat structure. Therefore, the predictability of β-diversity by habitat characteristics derived from remote sensing information should exceed that of α-diversity. Here, we model α- respectively β-diversity with optical texture metrics derived from remote sensing information as indicators for habitat structure using partial least-square regression. Our comparison is based on field data from four different taxa (trees, moths, ants, birds) in a mountain rainforest ecosystem in South Ecuador. The leave-one-out R^2 and root mean square error were used to assess the predictability of both diversity measures. For all four taxa, predictability of β-diversity was higher compared to the predictability of α-diversity. For the tree assemblages, predictability as measured by R^2 reached even 0.9. We explain this result by the fact that measures of β-diversity incorporate also information of the response of individual species to changes in habitat structure. Obviously this increases the predictability of such metrics on the landscape scale and thus enhances decision-making in conservation planning.

O45-03 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Abundance, richness and composition of lianas community along an altitudinal gradient in New-Caledonia

DAVID BRUY[1], THOMAS IBANEZ[2], JÉRÔME MUNZINGER[3], SANDRINE ISNARD[4]
[1]University of Montpellier - IRD, Laboratoire de Botanique et d'Ecologie Végétale Appliquées, 98848, Nouméa, New Caledonia
[2]IAC, Diversité biologique et fonctionnelle des écosystèmes terrestres, 98848, Nouméa, New Caledonia
[3]UMR AMAP - IRD, Biodiversité végétale, actuelle et passée, 34398, Montpellier, France
[4]UMR AMAP - IRD, Laboratoire de Botanique et d'Ecologie Végétale Appliquées, 98848, Nouméa, New Caledonia

Lianas represent an abundant and dynamic component of tropical forests and their abundance is predicted to increase with global changes. Better understanding of factors driving their distribution is consequently required, especially on islands that are the firsts concerned by global changes and for which very few data are available. Here we studied the abundance, richness and composition of lianas community along an altitudinal gradient in New Caledonia. This oceanic subtropical archipelago that exhibit a rich endemic flora and a marked orography is a great model to improve our knowledge on lianas ecology.
We inventoried lianas with Diameter at Point Of Measurement ≥ 1 cm in 27 forest plots (20 x 20m) along an elevation gradient between sea level and ca 1000 m. We explored the patterns between elevation and the abundance, the composition and the richness of lianas. Secondary hemi-epiphytes were also inventoried to investigate potential competition with lianas. We also tested the hypothesis that the climbing modes together with the sizes' distribution of potential tree hosts shape the lianas community.
We inventoried 992 lianas belonging to 71 species and 21 families. The abundance and basal area showed a logarithmic decrease with elevation while species richness peaked at mid-elevation. Twining climbers were the most abundant and species-rich functional group at all altitudinal levels while the other functional groups were affected by elevation. Passive climbers were more abundant and species-rich at low elevation, active climbers at mid-elevation and roots climbers at high elevation. Lianas were underrepresented on small trees and overrepresented on big trees independently of their climbing modes.
Both the decrease of lianas abundance with elevation and the peak of biodiversity at mid-elevation are in agreement with previous studies in mainland forests. The first pattern can be explained by more seasonality at low elevation, which make lianas more competitive, while the second is likely to results from the combined effects of high host-size heterogeneity at middle and high elevation and greater competitiveness of hemi-epiphytes toward the summit. The effect of elevation on climbing modes distribution reflects the importance of forest structure for liana communities. The overrepresentation of lianas on big trees is a widely observed pattern that can be explained because of bigger trees, being older, have more chance to accumulate lianas over time.

O45-04 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Do the foliar functional properties of liana assemblages differ from those of the trees they share the forest canopy with? A test on a rain forest altitudinal gradient in Costa Rica

BRYAN FINEGAN[1], SERGIO VILCHEZ[2], EDITH ARELLANO[1]
[1]CATIE, Production and Conservation in Forest, 93-7170, Turrialba, Costa Rica
[2]CATIE, Biostatistics Unit, 93-7170, Turrialba, Costa Rica

The abundance of lianas may be increasing pervasively in tropical forests, one possible reason being that they are functionally more acquisitive than trees. Better understanding of drivers of change in liana assemblages, however, should also take into account functional properties of whole assemblages. These considerations are especially important in forests on mountains because of the potential effects of climate change. In four old-growth rain forest types on infertile soils over a 440-2950 masl altitudinal gradient, we determined community weighted means (CWM, basal area-weighted) of six leaf traits. We asked whether liana CWM trait values are more acquisitive than those of the trees with which they share the forest canopy – higher CWM specific leaf area SLA and mass-based leaf nitrogen and phosphorous content (N, P) and lower leaf dry matter content LDMC. We also measured CWM N/P to determine whether lianas and trees may be nutrient-limited in different ways.
We identified and measured lianas >=2 cm stem diameter d and trees >=10 cm dbh in 30 square 0.25 ha permanent plots covering the altitudinal gradient. Leaf traits were measured using standard protocols for species forming 80% of basal area per plot for each growth form separately. We used general linear mixed models to compare CWM traits of the two growth forms, taking into account the effects of mean annual temperature MAT (Worldclim data) and plot soil characteristics synthesized by PCA. Plot was specified as a random factor.
No lianas >2 cm d were found in ten montane forest plots >1650 m asl, suggesting an overall temperature limitation on their distribution. For both growth forms in the three forest types with lianas, assemblage taxonomic composition differed significantly among forest types (ANOSIM, p<0.05). There were no differences between growth forms or relationships to environment for CWM N, SLA or LDMC. CWM P did not differ between growth forms but was negatively correlated with MAT and its associated soil gradient for both. CWM N/P was >16 overall, suggesting pervasive P-limitation, though it declined with MAT for trees. CWM N/P was significantly higher for trees than for lianas, suggesting that liana assemblages are less P-limited than trees. Our results suggest that strategies for acquisition and use of P in low-P soils are a primary functional difference between liana and tree assemblages in these forests.

O45-05 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Altitudinal gradients of tree species diversity and above-ground biomass on a small montane of Atlantic Central Africa

CHRISTELLE GONMADJE[1], NICOLASPICARD[2], SYLVIE GOURLET-FLEURY[3], MAXIME RÉJOU-MÉCHAIN[4], VINCENT FREYCON[3], TERRY SUNDERLAN[5], DOYLE MCKEY[6], CHARLES DOUMENGE[3]
[1]University of Yaounde I, Department of Plant Biology, 812, Yaounde, Cameroon
[2]FAO, Forestry Department, 00153, Rome, Italy
[3]CIRAD, Environment and society, 34398, Montpellier, France
[4]IRD, AMAP, 34000, Montpellier, France
[5]CIFOR, Forests and Livelihoods, 16000, Bogor, Indonesia
[6]CNRS, CEFE, 34293, Montpellier, France

Tropical forests are both important carbon sinks and among the most biodiverse ecosystems on the earth. Patterns in aboveground biomass (AGB) and their relationship with species diversity of tropical forests over short altitudinal gradients are poorly known and the few previous studies on the subject have yielded variable results. Here, focusing on old-growth forests in Atlantic central Africa, we investigated how AGB varies with altitude, and how this variation is related to altitudinal changes in floristic composition and/or forest structure. We also investigate the relationship between AGB and species diversity along the altitudinal gradient.
We inventoried all trees with a diameter (dbh) ≥ 10 cm in fifteen 1 ha permanent plots (100 m x 100 m) established along a transect from lowland (200 m) to submontane forests (900 m) in the Ngovayang Massif, southwestern Cameroon.
Our data show a negative relationship between AGB and tree species richness, related to the elevation gradient. Forest AGB varied two-fold along this gradient, decreasing from 500-600 Mg ha-1 in lowland plots to less than 300 Mg ha-1 at the highest altitudes, while diversity increased, from 35.4 to 54.6 (Fisher's alpha index). The decreasing trend in AGB was mainly due to large trees (dbh ≥ 70 cm) whose contribution to AGB significantly decreased with altitude while the contribution from smaller trees was constant. Tree height and basal area also decreased significantly with increasing altitude, whereas stem density increased. While maximum potential tree height significantly decreased, wood specific gravity displayed no trend along the gradient. In particular, we showed that AGB variation was mainly determined by shift in species composition because large tree species were filtered out in the highest altitudes. Hence, our work further highlight the need for studying the drivers of large tree species distribution to better understand forest carbon stock variations in tropical forests.
At the regional level, the Ngovayang massif was among the richest sites with highest level of biomass. Our results have strong implications in decisions on balancing carbon sequestration strategies with biodiversity conservation ones. Policy consequences are particularly relevant in forest management and land use planning.
Keywords: Carbon stocks, forest structure, biodiversity, submontane forests, niche filtering, altitudinal gradient.

O45-06 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Variation in fine root biomass and production after continued nutrient addition to Andean forests

JHENNY SALGADO, JÜRGEN HOMEIER
Georg-August-University of Goettingen, Albretch-von-haller-Institute for plant science, 37073, Göttingen, Germany

Background: A future increase of nutrient deposition could be expected for most tropical regions, probably causing different «fertilization effects». Nitrogen and Phosphorus geochemical cycles have been altered by human activities. There is evidence of more nutrient availability in forests of southern Ecuador caused by nutrients traveling from the amazon after biomass burning. In addition, previous studies indicate that nutrients inputs could affect carbon storage and allocation, and alter the species composition and diversity of forests.
Moreover, studies on nutrient addition effects on tropical forests are mostly from lowland forests and had their focus on aboveground parameters. Our study focuses on tropical montane forests because these are important carbon stores and the belowground carbon fraction is higher compared with lowland forests. The aim of our study was to contribute to a better understanding of root dynamics under increasing nutrient availability.
Methods: For our study, we used the ongoing Ecuadorian NUtrient Manipulation EXperiment (NUMEX) installed in January 2008. In this experiment, moderate amounts of N (50kg ha-1 yr-1), or P (10kg ha-1 yr-1), or N and P are added to representative old-growth forest stands at an elevational gradient of 1000, 2000, 3000 m asl. We evaluated the response of fine root production and biomass for 4 or more years of continued nutrient addition.
Results: Preliminary analyses showed a subtle effect of nutrient addition on the belowground biomass. For instance, we found a general decrease in fine root biomass/necromass ratio in all the treatments over the years.
Discussion: A better understanding of carbon allocation in tropical montane forests is important with regard to global change. We expect that our findings on effects of long-term nutrient addition to those forests can also be perceived in other similar forests in the tropical Andes, where human activities or environmental change are altering the nutrient cycle.

O45-07 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Could carbon save tropical montane forests in Africa?

AIDA CUNI SANCHEZ[1], CATHRINE SORENSEN[1], POMPEU PATRICIA[2], MARION PFEIFER[3], ROB MARCHANT[4], NEIL BURGESS[5]
[1]University of Copenhagen, Center for Macroecology, Evolution and Climate, 2100, Copenhagen, Denmark
[2]Federal University of Lavras, Department of Forestry, 37200-000, Larvas, Brazil
[3]Newcastle University, School of Biology, NE1 7RU, Newcastle, UK
[4]University of York, Environment Department, YO10 5DD, York, UK
[5]UNEP-WCMC, UNEP-WCMC, CB3 0DL, Cambridge, UK

Tropical montane forests (TMF) are of particular interest, for their species richness and endemism, but also for the services they provide to surrounding communities (e.g. water). With increasing human pressure and predicted changes in climate, conserving these fragile ecosystems is not easy, particularly in Africa. Although carbon storage in TMF has been regarded as low and little research has focused on them, recent findings from Mt Kilimanjaro highlight that TMF can store as much carbon as lowland rainforests, raising the interest of carbon projects in TMF.

We measured above ground biomass (AGB) in three TMF in northern Kenya. We established 100 x 25m permanent plots along an altitudinal gradient in each mountain and sampled all trees >10cm diameter following common forestry methods. Tree diameter, height and species were recorded and allometric equations were used to calculate AGB. Stem density, basal area, species richness and biodiversity index were also computed. Different methods were used to upscale carbon stocks from plot level to landscape level using satellite images.
Plots at mid altitudes had particularly high AGB, which was linked to large tree height and basal area. Plots with large specimens of Faurea saligna and Podocarpus were those with highest AGB (>600 Mg ha-1). While altitude had an important effect on AGB and vegetation structure, the effect on species composition was less obvious. The different methods used to upscale carbon stocks gave slightly different results, with forest type classification being an important factor.
Results highlight that certain types of TMF store important quantities of carbon, which supports the notion that carbon projects could be established to help conserve these ecosystems. An important issue which needs to be addressed is upscaling, as challenging terrains and complicated satellite image analysis (cloudiness, shades, steep slopes) difficult this task.

O45-08 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Host–plant translocations and novel plant–insect interactions along an elevational gradient in Papua New Guinea

SAM LEGI
Environmental Futures Research Institute, Griffith University, Griffith School of Environment, 170 Kessels Road, Nathan 4111, Brisbane, Australia

Historically, the spatial and temporal distribution of plants and animals on Earth has fascinated and inspired many researchers to seek explanations to describe pattern. This has led to models predicting species distributions under future climate change using long term observational data. These models predict species expanding their ranges or tracking climate change. The changes in species distributions can reorganise communities including food webs. While these models seem robust, there is a need for experimental data to complement observational data. Using 1,500 translocated individuals of 8 Ficus (Moraceae) species, we present and discuss results from Papua New Guinea. Papua New Guinea is one of few countries in the world still having a continuous forest from lowlands on the seacoast to the highlands at 4500 m a.s.l. We focus on plant–insect interactions and how food webs change using observational and experimental data.

O45-08 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Divergence and Convergence in High Altitude Specialists

LEONARD JENNIFER

Background: High altitude environments in the tropics can be very different that adjacent lowland areas. These habitats are inhabited both by high altitude specialists and by species distributed along large altitudinal gradients.
Methods: We use genetic tools in combination with other data to measure divergence between high and low altitude populations and between different highland populations of small mammals.Results: Surprisingly high levels of genetic divergence were found in several, but not all, species. Convergence in some morphological traits across divergent taxa have lead to taxonomic confusion in some cases. Discussion: High altitude populations are more divergent than expected in many cases, and may be subject to different, habitat specific selective forces.

O45-09 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Taxonomic, functional and phylogenetic diversity of birds in highly threatened ecosystems of the Colombian Andes

MAILYN GONZALEZ, ELKIN TENORIO, PAOLA MONTOYA, BEATRIZ SALGADO
Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá D.C., 111111, Bogotá, Colombia

Colombian Andes are among the most diverse world's biodiversity hotspots. Highly threatened by human settlement, these highland ecosystems now face major pressures from gold mining and agriculture. In this study, we focused on how bird taxonomic, phylogenetic and functional diversity vary through elevation and taxonomic scale, revealing ecological mechanisms of community assembly. Diversity components were assessed at a 1km^2 scale based on 325 species distribution models. Indices of functional dispersion (FDiv) were measured from five traits of 6000 individuals. Phylogenetic diversity was defined as the sum of branch lengths of bird species present in each community, which was assessed using a bird global phylogeny. We evaluated 29914 communities-cells, of which 11722 (39%) showed some functional or phylogenetic pattern of overdispersion or clustering. We found the three components of diversity to be decoupled. In fact, while taxonomic diversity decreased with elevation functional and phylogenetic diversity increased. Contrasting patterns of structure where found when assessing communities at different taxonomic levels and congruency between functional and phylogenetic diversity weakened at lower taxonomic ranks. Higher variance in functional traits at higher elevation reflects the dominance of competition for resources in harsh environments. This study depicts the patterns and processes of community assembly in the country with the highest number of bird species worldwide and provides helpful insights for future conservation planning of this world's hotspot.

O45-10 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Ecology of birds along an elevational gradient and their predation pressure on arthropods

KATERINA SAM[1], BONNY KOANE[2], VOJTECH NOVOTNY[1]
[1]Biology Centre CAS, Institute of Entomology, 37005, Ceske Budejovice, Czech Republic
[2]The New Guinea Binatang Research Centre, BRC, 604, Madang, Papua New Guinea

We present robust quantitative data on bird communities along a complete rainforest elevational gradient in Papua New Guinea. The gradient is located on the slopes of Mt Wilhelm, spanning from the lowland floodplains of the Ramu river (200 m a.s.l.) to the tree line (3700 m a.s.l.). We collected bird community data at eight sites (500 m elevational increment) during five independent surveys – in dry and wet seasons (2010-2015). Over the years, we conducted several extensive surveys including mist-netting, point-counts, and MacKinnon lists and recorded more than 50,000 bird individuals. Data indicate that species richness and abundance of birds is highest at the lowest elevations for all birds together, and for nectarivores and frugivores. However, the diversity and abundances of insectivores differs from the patterns observed in the other guilds. Diversity of insectivores remains constant until 1700 m a.s.l. and then decreases with elevation. Their abundance increased towards 1700 – 2200 m a.s.l., then declined. We found no evidence that geometric constraints influence observed patterns, whereas climatic variables accounted for the most of the variation in observed patterns, except those in insectivorous birds. Habitat complexity is the most important explanatory variable for insectivorous birds. Insectivorous birds were the most abundant guild along the gradient, and their species richness along the gradient decreased much faster than in any other feeding guild. Body size of an average insectivorous bird decreased with increasing elevation. Their body size also correlated with the insect-prey body size. Finding the insectivorous birds to be important ecologically, we surveyed their predation pressure and effect on communities of arthropods. We revealed that exclusion of birds from ecosystems leads to the increased abundances of arthropods and consequently also to increased herbivorous damage. The predation pressure was strongest at the mid- elevations, and decreased towards the lowest and the high elevational study sites. The project was financially supported by GACR 14-32024P.

O45-11 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Elevational changes in the structure of beetle assemblages in the tropical rainforests of northern Australia and Papua New Guinea

CARL WARDHAUGH[1], NIGEL STORK[2]
[1]University of South Bohemia, Biology Center, Czech Academy of Sciences and Faculty of Science, 370 05, České Budějovice, Czech Republic
[2]Griffith University, Futures Research Institute, Griffith School of Environment, 4111, Brisbane, Australia

Background: Changes in abiotic and biotic conditions with increasing elevation affect the diversity, abundance, and composition of plant and animal communities, while impending climate change is predicted to drive many species up mountains so they can remain within their abiotic tolerance limits.
Method: In order to uncover elevational patterns in the diversity and composition of tropical beetles, and to evaluate the impending threat of climate change to these functionally important species, we examined changes in beetle communities along two short elevational gradients (100-1,000m a.s.l.) in the rainforests of northern Australia, and one long elevational gradient (200-3,700m a.s.l.) in Papua New Guinea (PNG).
Result: In Australia, we found that species diversity and abundance generally increased from the lowlands to 1,000m, which contrasts with previous studies that either showed steady declines in diversity and/or abundance with elevation, or a mid-elevation peak. We also found little variation in species composition with altitude, as most common species (n>10) occurred across most elevations. In PNG, we found similar patterns below 1,200m to that in Australia, where species diversity increased with altitude from the lowlands and community composition was similar from 200-1,200m. However, at higher altitudes diversity declined, revealing a mid-elevation peak at 1,200m, and community composition changed abruptly to a distinct mid-elevation fauna from 1,700-2,700m.
Discussion: These results suggest that Australian rainforests are essentially all lowland forests, perhaps grading into mid-elevation forest at the highest elevations, and are not high enough to induce substantial elevational stratification in diversity and species composition. Fortunately, it also suggests that beetles in Australia's tropical rainforests are not particularly vulnerable to moderate climate change, since there were few high-elevational specialists.

O45-12 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
Wednesday 22 June / 10:00-15:30 – Antigone3

Trophic ecology of ants and spiders along a wide elevational gradient in Papua New Guinea revealed by stable isotopes

JUSTINE JACQUEMIN[1,2], DOMIR DEBAKKER[1], PETR KLIMES[3], MARK MARAUN[4], YVES ROISIN[2], MAURICE LEPONCE[1]
[1]Aquatic & Terrestrial Ecology, OD Nature, Royal Belgian Institute of Natural Sciences, Brussels, Belgium
[2]Evolutionary Biology & Ecology, Université libre de Bruxelles, Belgium
[3]Institute of Entomology, Biology Centre CAS, University of South Bohemia, Czech Republic
[4]Institute for Zoology and Anthropology, Ecology (AG Scheu), University of Göttingen, Germany

Ants occupy different trophic functions, from primary consumers (e.g. nectarivores) to predators. In tropical mountain forests their biomass and diversity decrease with elevation. With increasing elevation, shifts may be induced in their diet, and predatory ants could also be functionally replaced by other taxa such as spiders and predatory beetles. Direct observation of feeding behavior is difficult in the field and stable isotope analysis is a way to circumvent this issue by indicating the relative trophic position of the investigated taxa in the food web, giving evidence of prey-predator relationships or of resource competition. The aims were 1/ to study the quantitative and qualitative replacement of predatory ants by other predatory taxa along an altitudinal gradient; 2/ to verify whether ant species with wide altitudinal distribution occupy the same trophic position at different elevations.
Plants and arthropods were collected at 8 forest sites from 200 to 3700m on Mount Wilhelm, Papua New Guinea. In 5 plots per elevation, understorey arthropods were collected by beating of vegetation. Ants, spiders and beetles were counted and morphotyped. Their nitrogen and carbon stable isotope signatures were analyzed.
Ants were found up to 2200m and spiders up to 3700m, with abundance peaks at 1200m and 3700m respectively. The highest species richness for both ants and spiders was observed at 1200m. Two-third of ant species were found at a single elevation, 30% at two, and only three species were present at three elevations. Regarding spider species, 64% were found at a single elevation, 22% at two, and a few species were present from 200 to 3200m. The ant Meranoplus astericus was an ubiquitous species known in the literature as nectarivorous. Isotopic signatures revealed a shift of its trophic position with elevation: low at 1200m, corresponding to that of a primary consumer, but higher at 700m, suggesting a predatory diet. On the contrary, other ubiquitous species had similar isotopic signatures at different elevations, suggesting consistent dietary habits. Between 200 and 2700m, spiders were the top predators in the food web. At 3200 and 3700m they shared the top position with predatory beetles.
In conclusion, for some ant species found at different elevations, a shift in diet may occur. With increasing elevation, ants were quantitatively replaced by spiders, and predatory ants were functionally replaced by spiders and predatory beetles at higher elevations.

O46-01 – S46 Free session: Climate change in tropical ecosystems
Wednesday 22 June / 16:00-17:30 – Antigone3

Impacts of climate change on indigenous communities: role of botanic gardens in biocultural conservation

DUNN CHRISTOPHER
Cornell University, Cornell Botanic Gardens, 14850, Ithaca, USA

Global climate change is having a significant, and negative, impact on the biological diversity and, thus, on the integrity of natural systems. What is less well understood, yet just as critical, are the impacts of climate change and of changes in natural systems on indigenous peoples. In other words, as biological diversity is eroding, so too are cultural and linguistic diversity. In fact, of the approximately 7000 extant languages in the world, fully 50% are considered to be at risk of extinction, with the vast majority in the tropics and subtropics. This rate of extinction of languages (and thereby of human cultural diversity) is considerably higher than most estimates of extinction risks to plants and animals. In addition, traditional ecological knowledge and livelihoods are being lost. As an example of the latter, many tropical (and other) indigenous cultures rely on phenological or "ecological calendars" to determine appropriate timing of planting, hunting, harvesting, among other necessary activities. Climate change, and consequent impacts on natural systems and resources, is completely disrupting wellbeing of tropical communities. Thus, it is not enough to consider just the effects of environmental change on plant life within the current context of the global conservation initiatives, such as the Convention on Biological Diversity (e.g., Article 8(j)) and the Global Strategy for Plant Conservation. Botanic gardens are uniquely positioned to actively engage in understanding the broader impacts of environmental change to biocultural diversity to achieve biological, cultural, and economic resilience. Examples of how botanic gardens in several parts of the world are defining key ways to better understand tropical and cultural conservation will be presented.

O46-02 – S46 *Free session: Climate change in tropical ecosystems*
Wednesday 22 June / 16:00-17:30 – Antigone3

Micro-topographic variation and water abundance create heterogeneous landscapes for dipterocarp seedlings on alluvial plains

JAMES MARGROVE[1], CHRIS PHILLIPSON[1], ROBERT BAGCHI[2], JABOURY GHAZOUL[1]
[1]ETH Zurich, USYS, 8092, Zurich, Switzerland
[2]University of Connecticut, Department of Ecology and Evolutionary Biology, CT 06269, Connecticut, US

Background: A tremendous diversity of tree species inhabit the tropics, and a serious effort by scientists is to understand how they all coexist. A seemingly flat alluvial plane actually displays substantial micro topographic variation in concave and convex forms and combined with intra annual variation in water abundance during wetter periods creates ephemeral ponds throughout the land scape. Flooding reduces oxygen in the soil, causing a switch to inefficient anaerobic respiration and photosynthesis to shut down. Water's patchy distribution presents tree seedlings with a highly heterogeneous environment in the early stages of life creating openings for a competitive advantage in those that are more tolerant.
Methods: Our design contained 16 different species split equitably between 32 plots nested within 16 blocks in 64 fully randomised positions (2048 seedlings total). Each plot's micro-topography was mapped and linked together creating a single explanatory variable. Seeds we're sources directly from mothers accounting for any maternal effects, and a mixed effects model was used to analyse the data. Seedling census' were done every 3 month since December 2014.
Results: We find differences in the mortality of 16 dipterocarp species related to topography during the rainy period and during the subsequent dryer periods.
Conclusion: These unexplored micro processes that act on seedlings are influential in the maintenance of species diversity.

O46-03 – S46 *Free session: Climate change in tropical ecosystems*
Wednesday 22 June / 16:00-17:30 – Antigone3

Long-term forest dynamics in a Neotropical tropical rainforest landscape: assessing possible global warming sings

MIGUEL MARTÍNEZ-RAMOS
Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, Mexico

Background: With the increase of greenhouse gases in the atmosphere generated by human activities, it has been proposed that two emergent phenomena are affecting tropical rainforests: i) a CO2 fertilization effect, which purportedly is fostering photosynthesis, and hence forest biomass gain, and ii) a change in rainfall and temperature regimes, which is increasing forest turnover rates. In this paper, I used a long-term case study in the Biosphere Reserve of Montes Azules (MAB-UNESCO), at Southeastern Mexico, to assess this framework, investigating temporal and spatial changes in recruitment, growth, mortality, and biomass change rates of tropical rainforest more than 4,000 trees over 22 years.
Methods: All trees with a diameter at breast height (DBH) equal or higher than 10-cm were tagged, identified, measured in DBH, and monitored every year from 1994 to 2015 in fourteen 0.5 ha permanent plots, established among four geomorphological landscape units (3-5 plots per unit) varying in soil and topographic properties. The plots were separated by 3 to 25 km, within same landscape and climate.
Results and discussion: On average, over the 22 years tree density decreased 14% and biomass increased 11%. These results show that the forest is undergoing a fast thinning process, supporting CO2 fertilization hypothesis. However, biomass net gain was higher and forest turnover rate faster in the (rich-soil) alluvial sites than in karst (with high water drainage) and low-hills (with poor soil) sites, and even biomass decreased in swampy sites. In the alluvial and in the swampy sites forest dynamics exhibited stronger temporal changes than in the other sites, which resulted from faster growth and mortality rates. I discuss that the biomass increase and the faster forest turnover attributable to the rise of atmospheric CO2 and to climate change, is not a general phenomenon, but depend on other factors, such as soil nutrient and water availability levels. These results are important because predictions of the effects of fertilization need to be informed by actual long-term data and incorporate the variation across space an time.

O46-04 – S46 *Free session: Climate change in tropical ecosystems*
Wednesday 22 June / 16:00-17:30 – Antigone3

Environment and landscape features drive changes in Amazonian forest bird assemblages

JULIANA MENGER[1], WILLIAM MAGNUSSON[2], KLAUS HENLE[3]
[1]University of Leipzig, Faculty of Biosciences, Pharmacy and Psychology, 04103, Leipzig, Germany
[2]INPA - Instituto Nacional de Pesquisas da Amazônia, Coordenação de Biodiversidade, 69067375, Manaus, Brazil
[3]UFZ - Helmholz Center for Environmental Research, Conservation Biology, 04318, Leipzig, Germany

Background: Because of their high habitat specificity and ability to fly, the spatial distribution of tropical bird diversity is assumed to be driven primarily by environmental heterogeneity and interspecific interactions. However, Amazonian forest birds are extremely sedentary: the distributions of many species are restricted by large rivers, and territories of some understory species are known to be limited even by narrow roads, suggesting that dispersal limitation may also play a key role in driving species turnover.
Method: In this study, we evaluated the effects of environmental factors (topo-edaphic variables and vegetation structure) and dispersal limitation (geographical distances and landscape features) on spatiotemporal variation in bird diversity and assemblage structure in an old-growth forest in central Amazonia. Birds were mist-netted in 72 plots distributed systematically across a 10.000 ha reserve in each of three years. ANOVA was used to partition spatio-temporal variation in bird species richness, abundance and Shannon diversity. Permutational multivariate dissimilarity-based ANOVA and distance-based redundancy analysis were used to partition variation in bird assemblage structure.
Results: Alpha diversity remained stable through time, but species composition changed. Spatial variation in bird diversity and assemblage structure was significantly related to topo-edaphic variables and vegetation structure, but not related to geographical distance. In addition, the central ridge that divides the reserve into two watersheds acted as a boundary to limit the local distribution of some species, resulting in compositional differences between the two watersheds.
Conclusion: Our results indicate that complex topography and landscape features can act alongside with environmental variables to drive changes in the diversity and composition of tropical forest bird assemblages.

O46-05 – S46 *Free session: Climate change in tropical ecosystems*
Wednesday 22 June / 16:00-17:30 – Antigone3

Operative temperatures and stress response in Puerto Rican Anolis lizards

LUISA OTERO[1], RAYMOND HUEY[2]
[1]University of Puerto Rico, Biology, 00931, San Juan, Puerto Rico
[2]University of Washington, Biology, 98195, Seattle, USA

Stress can negatively affect organisms and reduce their capacity to survive and reproduce. Physiological stress can be triggered by biotic and abiotic factors such as reproductive condition, diseases, parasites, inter and intra-specific interactions, and habitat quality.
One can use physiological stress responses as indices of whether various environmental factors are affecting organisms. We studied the stress response (corticosterone) of Puerto Rican Anolis lizards and examined whether the magnitude of the stress response of these lizards was positively correlated with environmental operative temperatures (Te) of the habitat. We expected to find higher baseline corticosterone levels on those lizards living in lowland habitats where temperatures are relatively high, compared to conspecifics living in cooler montane habitats. We also expected to find higher corticosterone baseline levels during the summer than in winter, and in open warm habitats than in cooler forests.
Because tropical ectotherms are especially sensitive to temperature changes, establishing whether stress is correlated with Te provides a mechanistic index of the impact of climate warming on tropical ectotherms.
We assessed the stress response by measuring glucocorticoid concentrations in blood. We took post orbital blood samples within the first two minutes after capture. We sampled 15 Anolis gundlachi at low, mid and high altitude during summer and winter seasons. For Anolis cristatellus we took blood samples during summer and winter from populations living in open and forest habitats. Corticosterone levels were measured via radioimmunoassay. To estimate heat loads, we deployed data loggers at each field site and recorded Te every 15 minutes for over a year. Finally, we built linear models to test if stress hormones concentrations varied among season and sites for the sampled species.
Stress hormones concentrations did not differ among seasons ($p < 0.51$) nor with altitude ($p < 0.19$) for A. gundlachi, nor did they differ among seasons nor habitats types for A. cristatellus ($p < 0.98$). Stress hormone levels were not significantly correlated with Te's, despite major differences in Te's in highlands vs. lowlands, open vs. forests, and summer vs. winter season in Puerto Rico.
These seasonal and geographic patterns suggest that Puerto Rican anoles are not currently experiencing heat stress. Whether those patterns will change in a warming world remains to be seen.

O46-06 – S46 *Free session: Climate change in tropical ecosystems*
Wednesday 22 June / 16:00-17:30 – Antigone3

Differential response of Andean frogs by elevational range to Pleistocene climate change inferred form a distribution modeling analysis

ANDREA PAZ[1], ANGELICA GONZALEZ[2], ANDREW CRAWFORD[2]
[1]CUNY, Graduate Center, 10016, New York, USA
[2]Universidad de los Andes, Biological Sciences, 111711, Bogota, Colombia

Background: Recent climatic models of the late Pleistocene suggest that the world was not only colder, but also ranged from wetter to drier in different parts of the world. If those shifts occurred more rapidly than the rate of adaptation of local species, the latter likely shifted their ranges as populations tracked optimal environmental conditions. In montane areas, where environmental conditions vary sharply over short geographic distances, species were forced to move vertically. We hypothesize that high elevation species moved downward to avoid the colder conditions of mountaintops, while lowland species moved upwards to avoid the arid conditions.
Methods: To examine this bi-directional scenario we modeled the paleo-distribution of amphibians, which are sensitive to environmental conditions given their poikliothermic physiology and permeable skin, in the Colombian Andes. Specifically, we evaluated the relative response of six montane and eight lowland amphibian species to climate change, comparing modeled ranges under conditions of the last glacial maximum (LGM) and the present, using correlative Species Distribution Modeling (SDM). For these fifteen species, we inferred the direction of the predicted shifts in elevation and evaluated possible environmental refugia, i.e., areas predicted to have maintained suitable climatic conditions for a given species in the face of global climate change. We produced SDMs under present-day climate and two projections for LGM conditions, the Community Climate System Model (CCSM) and the Model for Interdisciplinary Research on Climate (MIROC).
Results: In agreement with palynological-derived models for Andean flora, the projection of current SDMs onto historical models suggest that the mean altitudinal range of montane amphibians was lower and wider during glacial maxima. We inferred that high-elevation amphibians had wider distributions during the LGM, suggesting that areas of contemporary distribution represent current refugia. Lowland species, on the other hand, showed no change in altitudinal range during the LGM and did not have a consistent pattern on area change.
Conclusion: Understanding how species respond and adapt to changing environmental conditions is of main importance - particularly now, as the Earth's temperature increases more rapidly than ever. Our results generate spatially explicit hypothesis about amphibian responses to climate change that can be tested with phylogeographic data in the near future.

O47-01 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
Wednesday 22 June / 10:00-12:00 – Rondelet

Old-growth savannas and tropical ecosystem degradation

JOSEPH VELDMAN
Iowa State University, Ecology, Evolution, and Organismal Biology, 50011, Ames, USA

To effectively conserve tropical biodiversity we must develop scientifically based, culturally resonant concepts for undervalued ecosystems. An example of this is the old-growth grassland concept, whose development was motivated by the need to distinguish ancient, biodiverse grasslands, including tropical savannas, from recently degraded forests. Long periods of time are critical in the formation of old-growth savannas, but signs of their antiquity are not widely recognized. To survive frequent fires and grazing – forces that maintain savannas, but degrade forests – many savanna plants develop specialized underground organs that enable them to resprout repeatedly. Hence, evidence of plant longevity and ecosystem carbon storage often reside belowground. At the community level, savanna antiquity is reflected in high species richness, high endemism, and unique species compositions. Old-growth savanna communities require centuries or longer to re-assemble following severe degradation, including intensive human land uses (e.g., tillage agriculture) or altered disturbance regimes (e.g., fire exclusion). But despite evidence of their antiquity and irreplaceability, a great deal of confusion persists among scientists, policymakers, and land managers about the ecology and conservation values of old-growth savannas. I trace the history of this confusion over the past century to: misinterpretations of the nature of fire in savannas; attempts to reconcile savanna ecology with Clementsian succession; use of physiognomic definitions of savanna; and, development of tropical degradation frameworks focused solely on forests. Toward clarity, I present a model that conceptualizes the drivers of tropical ecosystem degradation as operating in both savannas and forests. This model highlights how human-induced environmental changes create ecosystems with superficially similar physiognomies but radically different conservation values. Data from eastern lowland Bolivia demonstrates the failure of physiognomy (i.e., tree canopy cover) and the usefulness of basic floristic information (e.g., grass species identities) to distinguish old-growth savannas from severely degraded forests.

O47-02 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
Wednesday 22 June / 10:00-12:00 – Rondelet

Drivers of land-cover change and their welfare consequences in the Brazilian Cerrado

MÁRIO DO ESPÍRITO-SANTO[1], MARCOS LEITE[2], JHONATHAN SILVA[1], RÔMULO BARBOSA[3], ANDRÉ ROCHA[2], FELISA ANAYA[4], MARIANA DUPIN[1]
[1]Universidade Estadual de Montes Claros, Departamento de Biologia Geral, 39401-089, Montes Claros, Brazil
[2]Universidade Estadual de Montes Claros, Departamento de Geografia, 39401-089, Montes Claros, Brazil
[3]Universidade Estadual de Montes Claros, Departamento de Ciências Sociais, 39401-089, Montes Claros, Brazil
[4]Universidade Estadual de Montes Claros, Departamento de Saúde Mental e Coletiva, 39401-089, Montes Claros, Brazil

Background: The Brazilian Cerrado is a tropical savannah biome that covers approximately 2 million km^2, including many physiognomies such as grasslands, shrublands, woodlands, rupestrian fields and riparian forests that compose a naturally complex and heterogeneous landscape. Until 2010 the accumulated deforestation in the Cerrado was 990,000 km^2 (almost 50% of total area), mainly because of the expansion of croplands, such as soybean, and pasturelands for beef production. We aimed to determine land-cover changes from 2000 to 2015 in the Cerrado at the north of Minas Gerais state (128,000 km^2), Brazil, and analyse 13 potential biophysical and social-economic drivers of deforestation, natural regeneration and net cover change at the municipality level. We also evaluated the effects of these land-cover changes in human welfare indicators.
Methods: For the determination of land cover changes, we obtained Landsat 5 imagery for the North of Minas Gerais for the year 2000, and Landsat 8 for 2015. We defined three land cover classes: Cerrado (with no differentiation between physiognomies), silviculture (pinus and eucalyptus plantations) and other (natural vegetation other than Cerrado, croplands, pasturelands, urban and burned areas, roads, bare soils and water). Drivers and land cover change were obtained by remote sensing and census data.
Results: we detected extensive land cover changes in the study area, with the deforestation of 23,446 km^2 and the natural regeneration of 13,926 km^2, resulting in a net loss of 9,520 km^2. The annual net loss (-1.2%) of Cerrado cover in the study region is higher than the reported for the whole biome in similar periods. None of the drivers affected regeneration, but the role of conservation units of sustainable use in this process deserves further attention, with potential contribution to REDD+ projects in the Cerrado. The main drivers of deforestation were linked to cattle ranching: declivity, climate type and change in cattle density, indicating that the most severely affected areas are lowlands with higher precipitation levels.
Conclusions: the hegemonic development model rooted in deforestation and large-scale commodity production, fostered by government policies for the Cerrado, should be urgently reviewed, because it causes long-term environmental impacts with no evidence of welfare gains.

O47-03 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
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The need of fire for conservation and restoration of Cerrado grasslands

GISELDA DURIGAN[1], GEISSIANNY ASSIS[2], RODOLFO ABREU[3], NATASHI PILON[4]
[1]Instituto Florestal, Floresta Estadual de Assis, 19807-260, Assis, Brazil
[2]Fundação Jardim Botânico do Rio de Janeiro, 22460-030, Rio de Janeiro, Brazil
[3]North Caroline State University, Department of Plant and Microbial Biology, 27695-7612, Raleigh, USA
[4]Universidade Estadual de Campinas, Instituto de Biologia, 13083 – 865, Campinas, Brazil

Background: While many nations with fire-dependent ecosystems already prescribe use of fires for conservation and restoration, Brazil still does not. The extensive misuse of fire for deforestation or pasture management in the past lead to an overall perception that fire is always negative and to the misunderstanding that Cerrado – the Brazilian savanna – is a product of forest degradation. The Cerrado comprises a mosaic of vegetation types from grasslands through savanna woodland to forests, related to environmental factors and maintained by fire at different frequencies and intensities over millions of years, since before humans started burning forests. In the absence of fire, dense uniform tall vegetation has replaced savanna grasslands in many sites, with severe consequences on biodiversity and hydrological processes. Besides the use of fire to manage vegetation structure, prescribed fires shall be included among ecological restoration tools. Cerrado restoration depends, in general, on controlling invasive species such as African grasses and pine trees, that pose strong ecological filters constraining natural regeneration and also the establishment of native species introduced by active restoration techniques.
Method: We monitored changes in native Cerrado vegetation after fire suppression and carried out restoration experiments after biological invasion of Cerrado grasslands by African grasses and slash pine. Prescribed burning was among the restoration techniques applied.
Results: Woody encroachment, biodiversity losses and decrease in the amount of rain reaching the ground are among the consequences of fire suppression in the Cerrado. Plant invasion has caused biodiversity losses and environmental changes. Fire eliminated the ecological filters posed by invasive pines, but African grasses need more than just fire to be controlled. In both cases, active re-introduction of native species is necessary to surpass the filters constraining spontaneous colonization.
Discussion: Cerrado conservation requires re-establishing the historical fire regime under which the mosaic of vegetation types existed. The use of fire in the restoration of Cerrado grasslands after biological invasion is promising, but depends, in general, on additional strategies. Fire has the potential to revert the negative consequences of both woody encroachment and biological invasion and must be incorporated to the current practices for Cerrado conservation and restoration.

O47-04 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
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Tree expansion in subtropical South American grasslands

MILENA HOLMGREN[1], RAFAEL BERNARDI[1], JASPER BUIJS[1], IVAN HERNANDEZ-SALMERÓN[1], INGER DE JONGE[1], ROCIO MARTÍNEZ-CILLERO[1], NESTOR MAZZEO[2], BART VERDIJCK[1]
[1]Wageningen University, Resource Ecology, 6708 PB, Wageningen, The Netherlands
[2]CURE-Universidad de La Republica, Uruguay

The almost treeless grasslands of subtropical South America have fascinated ecologists for centuries because these regions have high levels of precipitation that could potentially enable higher tree cover. We combined field surveys and experiments to assess the patterns and mechanisms that explain tree cover expansion into the grasslands of Uruguay.
We found that tree cover is concentrated close to rivers. In the ecotone between riverine forests and adjacent grasslands, we found a considerable overlap in tree species composition suggesting that the regional species pool is adapted to the range of environmental conditions found at this ecotone. Tree recruitment into grasslands is facilitated under the canopy of isolated thorny trees and shrubs. Field experiments show that early tree seedling establishment is strongly limited by livestock grazing whereas the effects of tree shade and grass cover shift from neutral to positive during the growing season depending on the species. Successful tree recruitment forms patches that reach highest species richness at intermediate patch size with a combination of early and late successional tree species. Our results contribute to understand the process of forest expansion into these subtropical grasslands.

O47-05 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
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Campos rupestres, a neglected conservation priority

SOIZIG LE STRADIC[1], FERNANDO A.O. SILVEIRA[2], GERALDO W. FERNANDES[3], ELISE BUISSON[1]
[1]Université d'Avignon, IMBE, CNRS, IRD, Aix Marseille Université, IUT d'Avignon, 84911, Avignon, France
[2]Universidade Federal de Minas Gerais, Departamento de Botânica, 31270-901, Belo Horizonte, Brazil
[3]Universidade Federal de Minas Gerais, Departamento de Biologia Geral, 31270-901, Belo Horizonte, Brazil

Background: While Cerrado, composed of a mosaic of formations ranging from forests to savannas and grasslands, is included among the 35 terrestrial biodiversity hotspots, 50% of its 2 million km² have already been converted to other land-uses. In recent years (1995 to 2006), 11 percent of forested areas and nearly 27% of natural grasslands were lost. Among the Cerrado grassland formations, campos rupestres are a mosaic of megadiverse, montane fire-prone grasslands, associated with rocky quartzite, sandstone or ironstone (canga) outcrops, which originally covered 66,447 km².
Discussion: Major current threats include opencast mining, annual anthropogenic burnings to support the cattle industry, invasive species, harvesting of ornamental plants, road construction and uncontrolled urbanization, especially linked to tourism expansion, and eucalypt plantations, despite unsuitable soils for such purposes. While Brazilian strictly-protected areas (categories I to III in the IUCN) increased of nearly 29% between 2005 and 2014 (from 370,197 km² to 520,251 km²), less than 30 km² of canga were incorporated into such protected areas. Campos rupestres are thus under threat and this talk aims at presenting the reasons why they should become a conservation priority: Campos rupestres are old-growth grasslands with megadiverse flora: they harbor more than 5000 vascular plant species, 14.7 % of the entire Brazilian flora in less than 1 % of the country's surface. They also provide major ecosystem services, such as water storage and recharge provisioning as they are found in the heads of many of the most important Brazilian watersheds. Campo rupestre vegetation is highly vulnerable to soil disturbance, predominance of species with reduced dispersability and high local endemism makes it nearly impossible to restore.

O47-06 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
Wednesday 22 June / 10:00-12:00 – Rondelet

Temperature and resource type shape ant-plant interactions in Brazilian rocky grasslands

FERNANDA COSTA[1], MARCO MELLO[1], LAURA BRAGA[2], BRUNA BOA SORTE[2], JUDITH BRONSTEIN[3], FREDERICO NEVES[1]
[1]Federal University of Minas Gerais, Programa de Pós-Graduação em Ecologia, Conservação e Manejo da Vida Silvestre, 478, Belo Horizonte, Brazil
[2]Federal University of Minas Gerais, Biological Sciences Department, 478, Belo Horizonte, Brazil
[3]University of Arizona, Ecology and Evolution Department, 85721, Tucson, EUA

Interactions between ants and plants are mediated by different kinds of resources. These interactions generate vital ecosystem functions and services, such as defense against natural enemies, pollination, and seed dispersal, forming complex networks, whose structure may vary with factors both intrinsic and extrinsic to the community. We tested whether resource type and climate variability throughout the year affect the structure and dynamics of ant-plant networks. For one year, at the peak and transitions between rainy and dry seasons, we monitored ant-plant interactions in seven sites at similar altitude and with similar climate, in the Serra do Cipó Mountains in southeastern Brazil, a site characterized as campo rupestre (rocky grassland environment). Based on our field observations, we built a multi-relational network formed by four types of resources: extrafloral nectaries, flowers, trophobionts, and fruits. Interactions with extrafloral nectaries were the most diverse and abundant within the network, followed by interactions with flowers, trophobionts and fruits. Interactions with trophobionts and flowers formed networks with higher niche overlap among ants than extrafloral nectaries. In addition, interaction richness and frequency increased with temperature, but rainfall had no effect. The five most central ant species were the same in all interaction types and seasons: Cephalotes pusillus, Camponotu srufipes, Camponotus crassus, Brachymyrmex heeri, and Brachymyrmex sp1. In summary, the structure of ant-plant networks varies with resource type and temperature, but the central species seem to remain the same. Those findings suggest a multi-layered community structure, in which different subnetworks are linked to one another by a small set of ant species able to persist under resource and temperature variation. We highlight the potential of ant-plant interactions as good models to investigate ecosystem functioning and conservation of tropical grasslands environments.
Funding: CNPq, Capes, Fapemig, UFMG-PRPq, PELD-CRSC, PPBio-MA, Humboldt Foundation, DAAD, Ecotone.

O47-07 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
Wednesday 22 June / 10:00-12:00 – Rondelet

Challenges in extreme tropical grasslands

GREGORY MAHY, SYLVAIN BOISSON, SOIZIG LE STRADIC
University of Liege, BIOSE - Biosystem Engineering Department, Biodiversity and Landscape Unit, 5030, Gembloux, Belgium

Background: One of the greatest contemporary challenges consists in the integration of economic activities with environmental integrity and social concerns, especially in case of mining activities. Southeastern of the Democratic Republic of Congo and adjoining regions in the North of Zambia, called the "Copperbelt", comprise more than a thousand Copper-Cobalt outcrops scattered over more than 400 km (W-E). Metalliferous ecosystems host unique vegetation, often composed of rare and endemic species, able to survive in soils containing high concentration of metal. Metallophyte species present physiological mechanisms, which exclude or accumulate the trace metals in their tissues in order to avoid their presence in excess in plant cells. Most Cu-Co outcrops have now been allocated to mining companies and are expected to be impacted in the coming years and decades. In the last years, in transition to environmentally responsible operations, some actors of the mining industry are changing their environmental and social practices and have been developing conservation and restoration actions before, during and after the extraction phase in order to conserve this unique vegetation.
Methods: Actions include in-situ conservation and ex-situ conservation through the storage in safe locations of directly threatened species using species translocation, direct seeding, topsoil and community translocation and seed bank conservation of the most characteristic species. Aims of implemented actions are i) to gain information and experience on the feasibility of restoration program for copper vegetation and understand which process can limit the restoration of copper communities and, ii) to temporarily store and conserve native copper plant diversity in order to reestablish it on post-mining sites.
Results: While some technics as community translocation or direct seeding prove to be efficient to conserve and restore Cu-Co ecosystems and endemic species, some actions like topsoil transfer, did not provide results as expected or are limited like in-situ conservation.
Conclusion: It is essential to increase and promote effective restoration programs using native plant and deliver appropriate know-how to mining companies if we are to avoid the widespread use of exotic species in the revegetalisation of ecologically compromised areas.

O47-08 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
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Using phytostabilisation as a way to conserve threatened endemic species from the Southeastern D.R. Congo

SYLVAIN BOISSON[1], SOIZIG LE STRADIC[1], MAXIME SÉLECK[1], JULIEN COLLIGNON[1], OLIVIER GARIN[1], MYLOR NGOY SHUTCHA [2], GRÉGORY MAHY[1]
[1]Gembloux Agro-Bio Tech (ULg), BIOSE, 5030, Gembloux, Belgium
[2]Faculty of Agronomy (University of Lubumbashi), Ecology, Restoration Ecology, 1825, Lubumbashi, Democratic Republic of Congo

Metalliferous outcrops of the southeastern Democratic Republic of Congo are recognized as some of the largest copper-cobalt deposits of the world. They support unique vegetation with around 600 metallophyte species including rare and endemic species. Since 1900s, the exploitation of the Cu-Co outcrops in D.R. Congo has considerably increased, impacting environment and putting public health at risk. Phytostabilisation is a suitable technology to decrease the bioavailability of heavy metals in highly polluted soils. This technic has been successfully implemented in the vicinity of Lubumbashi with the grass Microchloa altera. The long term maintenance of such technic requires a good understanding of the interspecific relationship like competition and facilitation. This study aims to test the success of establishment of four herbaceous species from the southeastern DRC presenting conservation priority and to assess the potential role of M. altera as nurse plant in this context. Two annual species and two perennial species were sown in experimental design with soil amendments crossed with vegetation cover. The emergence, the growth and the survival were followed during the vegetation season and the resprout was measured for perennial species. M. altera had a distinct effect on the emergence and the survival of the annual and perennial species but affected negatively the growth of individuals for all species.

O48-01 – S48 *Free session: Ecology and conservation of tropical soils*
Wednesday 22 June / 14:30-15:30 – Rondelet

Litter traits modulate the effect of temperature on decomposition along a tropical elevation gradient in the Peruvian Andes

LETTICE HICKS[1], ANDREW NOTTINGHAM[1], YANN SALMON[2], JEANETTE WHITAKER[3], DAVE REAY[1]
ADAN CCAHUANA[4], NORMA SALINAS[5], PATRICK MEIR[6]
[1]University of Edinburgh, School of Geosciences, EH9 3FF, Edinburgh, United Kingdom
[2]University of Helsinki, Department of Physics, FI-00560, Helsinki, Finland
[3]Centre for Ecology & Hydrology, Lancaster Environment Centre, LA1 4AP, Lancaster, United Kingdom
[4]Universidad San Antonio Abad, Facultad de Ciencias, -, Cusco, Peru
[5]Pontificia Universidad Católica del Perú, Sección Química, -, Lima, Peru
[6]The Australian National University, Research School of Biology, ATC 2601, Canberra, Australia

Climatic warming is predicted to increase rates of decomposition with consequences for global carbon cycling. Yet, because we do not fully understand how multiple interacting chemical, biological and physical drivers determine decomposition rates, especially in tropical ecosystems, we cannot accurately predict the magnitude of this response to increased temperature.
We investigated how the effect of temperature on decomposition is modulated by litter chemical traits, soil properties and the presence of invertebrate macrofauna, by reciprocally translocating the litter of 8 plant species among 5 sites along a 3400 m tropical forest elevation gradient in the Peruvian Andes (extending from 194 m to 3644 m elevation). Litterbag mesh-size was used to manipulate macrofaunal access, to examine the distinct controls on decomposition in the presence and absence of invertebrate macrofauna.
Across the elevation gradient, decomposition rates were determined principally by temperature and litter traits, irrespective of differences in soil fertility. Litter carbon and nitrogen content strongly regulated decomposition rates, with a smaller secondary role of litter carbon chemistry (cellulose and lignin content). Invertebrate macrofauna accelerated decomposition at lower elevations, but had a negligible effect at higher elevation sites above 1500 m.
Although temperature influenced decomposition across the gradient, it was a stronger constraint at cooler mid-to-upper elevations, suggesting a higher temperature sensitivity and vulnerability of tropical montane systems to climatic warming. The significant role of litter chemical traits in regulating decomposition across the gradient, and the role of macrofauna in accelerating decomposition at lower elevation sites suggests that plant and soil biotic community composition modulate the climatic sensitivity of decomposition. Hence, modified litter chemistry and distributional shifts in macrofaunal abundance, as consequences of climate change, have the potential to accelerate rates of decomposition across tropical ecosystems, above that predicted by increasing temperature alone.

O48-02 – S48 *Free session: Ecology and conservation of tropical soils*
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Root respiration drives patterns of total soil CO2 from cultivated tropical peatlands

FRANCES MANNING[1], KHOON LIP KHO[2], TIM HILL[3], MOHD. HANIFF HARUN[4], ZULKIFLI HASHIM[4], YIT ARN TEH[1]
[1]University of Aberdeen, Institute of Biological and Environmental Sciences, AB24 3UU, Aberdeen, UK
[2]Malaysian Palm Oil Board, Tropical Peat Research Institute, Biological Research Division, 43000, Selangor, Malaysia
[3]University of Exeter, Department of Geography, EX4 4RJ, Exeter, UK
[4]Malaysian Palm Oil Board, Agronomy and Geospatial Technology Unit, Biological Research Division, 43000, Selangor, Malaysia

Introducing human management into peatland ecosystems alters the nutrient balances of the system. It is important to understand the biogeochemical processes present in the system in order to introduce optimal management practices for the nutrient cycling. For instance, draining tropical peat soil for agriculture can cause large losses of soil carbon to the atmosphere, due to water table drainage accelerating rates of peat oxidation. Determining the rate of peat oxidation from total soil respiration measurements is difficult due to the confounding effect of root respiration on total soil respiration. However, it is possible to account for the effect of root respiration on total soil respiration in oil palm plantations with spatially explicit sampling because plant (and root) biomass is spatially stratified.
Soil respiration and its components were determined by sampling CO2 fluxes in transects away from individual palms into largely unvegetated inter-palm spaces. The effects of surface management practices were taken into account by sampling in the principal management microforms: bare soil, decaying frond piles, and in rows planted with herbaceous cover plants. Root biomass was sampled destructively directly below the location of the soil respiration measurements.
Soil respiration and root biomass were both much higher by the palm than further away. Plantation-level estimates of peat oxidation (i.e. heterotrophic respiration) could therefore be determined from the spatial sampling design. Area-weighted up scaling was used to estimate plot level rates of total soil respiration and autotrophic respiration.
Comparing heterotrophic respiration rates with current literature values suggests that the peat oxidation determined in this work is relatively low, perhaps due to higher water table depths on the plantation at the time of measurement. Similarly, spatial designs should be employed for accurate plot level estimations of peat oxidation in order to take into account the high levels of variation in the system.

O48-03 – S48 *Free session: Ecology and conservation of tropical soils*
Wednesday 22 June / 14:30-15:30 – Rondelet

Abrupt, non-linear responses of soil heterotrophic respiration (RH) to intense climatic fluctuations may result in rapid losses of soil organic carbon in tropical high elevation ecosystems (Páramos)

JORGE CURIEL-YUSTE[1], ANA-MARIA HERES[1], GERARDO OJEDA[2], ANDREA PAZ[3], CAMILA PIZANO[4], DANIEL GARCIA-ANGULO[1], ELOISA LASSO[5]
[1]Museo Nacional de Ciencias Naturales, MNCN, CSIC, 28006, Madrid, Spain
[2]Universidad Nacional de Colombia, Ciencias Biologicas, 763533, Palmira, Colombia
[3]City University of New York, Biology, 10016, New York, USA
[4]Instituto Humboldt y Universidad Icesi, Ciencias Biologicas, 760012, Cali, Colombia
[5]Universidad de los Andes, Ciencias Biologicas, 71111, Bogota, Colombia

Páramos, tropical alpine ecosystems in the northern Andes, account for some of the largest soil C pools worldwide. Historically they had been carbon reservoir but expected changes in temperature and precipitation, as predicted by global change scenarios, may turn them in important carbon sources.
Method: To gather information on the potential vulnerability of these large soil C reservoirs to climate change, we evaluated the sensitivity of heterotrophic respiration (RH) to changes in temperature and soil moisture regimes in a factorial experiment under controlled conditions. Soil samples were collected from two Páramo sites located in the Eastern range of the Colombian Andes and were subjected to 4 temperature treatments (8, 22, 29 and 37°C). Temperatures between 8 and 22°C are generally experienced by soils in Páramos under natural conditions, whereas 29 and 37°C are temperature above ambient that simulate possible upcoming scenarios of warming and extreme events (heat-waves). RH measurements were taken using an EGM-4 portable system every 24 hours during 3 weeks, starting in flooded soils and until soils were dry.
Result: We found unexpected anaerobic pulses of RH-derived CO2 under waterlogged conditions, evidencing the extremely, and largely unknown, high metabolic resilience to fluctuations in O2 availability of soil microbial communities of these systems. On the other hand, low responsiveness to increases in ambient temperatures (8-22 °C) but abrupt increases in RH under warmer-than-ambient temperatures (29-37 °C) resulted in non-linear responses not well explained by simple Arrhenius-like exponential relations, suggesting that other processes, e.g. thermodynamic boundaries of decomposition of recalcitrant soil organic matter (SOM) fractions, should be taken into account.
Discussion and conclusion: Overall, our data suggests that we still lack a complete mechanistic understanding of all the processes and metabolic pathways involved in microbial CO2 productions and their sensitivity to intense climatic changes. While increases in RH-derived soil CO2 emissions from Páramos in response to baseline temperatures are lower than expected, anaerobic pulses of CO2 and abrupt increases in RH at warmer temperatures suggest that an increasing incidence of heat-waves and/or increasingly severe rain episodes (e.g. el NIÑO years) may result in substantial and rapid losses of CO2 hardly compensated by parallel increases in ecosystem CO2 uptake.

O48-04 – S48 *Free session: Ecology and conservation of tropical soils*
Wednesday 22 June / 14:30-15:30 – Rondelet

Mapping soil conditions from fern occurrences in Amazonia

GABRIELA ZUQUIM[1], JULIANA STROPP[2], HANNA TUOMISTO[1]
[1]University of Turku, Biology, FI-20014, Turku, Finland
[2]Federal University of Alagoas, Ciências Biológicas, 57072-900, Maceió, Brazil

Several soil maps are available for Amazonia but all of them contain large areas where data have been spatially extrapolated from sparse soil samples because there is a general paucity of ground data. In areas where soil collections are lacking, soil characteristics can be inferred from biological data, if available. Biotic communities have widely been used as predictors of the environmental conditions in paleo-environmental reconstructions and more recently, to map present-day environmental conditions at small scales. We have focused on ferns community composition as indicator to map edaphic conditions in Amazonia.
We compiled records obtained from 1205 plots across the Amazon basin and from the Botanical Information Ecology Network (BIEN) database. Soil samples were also collected from the plots and analysed in laboratory. We used the plot-based records to calculate the optimum value of occurrence of species along edaphic gradients. We then divided Amazonia into 895 grid cells of 100x100 km and estimated the environmental conditions of each cell for the whole basin. To achieve that, we used the average optimum of all the species recorded in each cell based on occurrences from all databases. We selected species that were previously known as good indicators and that are relatively easy to identify to minimize the effect of misidentifications across databases.
Fern species optima were well spread along the full environmental gradient. Several species, e.g. Trichomanes pinnatum were consistently found in the same soil type across the whole basin allowing transferability of the results among areas within Amazonia. We then generated a soil map based on the compiled fern information and compared with the most reliable soil map with information about sum of bases available, the soil and terrain database for Latin America and the Caribbean (SOTERLAC).
Soil ground data is the most reliable measure of edaphic characteristics but due to the small-scale variation of soil nutrient content in many areas in Amazonia, a complete survey of such characteristic is not possible. Ferns are good indicators of nutrient content it is feasible to tap edaphic information from species lists, floras and herbarium records through online databases such as the Global Biodiversity Information Facility (GBIF) or BIEN. This type of data tends to cover broader geographical areas than plot-based data and both can be combined to improve the present day available soil maps.

O49-01 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
Wednesday 22 June / 16:00-17:30 – Rondelet

Testing the link between pyrodiversity and biodiversity across African savannas

PARR KATE[1], BEALE COLIN[2], HEMPSON GARETH[3], MORRISON THOMAS[4], COURTNEY-MUSTAPHI COLIN[2], ARCHIBALD SALLY[3], PROBERT JAMES[1], DONALDSON JASON[3], DOBSON ANDY[5], ANDERSON MICHAEL[6]
[1]University of Liverpool, Earth, Ocean & Ecological Sciences, L69 3GP, Liverpool, UK
[2]University of York, YO, York, UK
[3]University of the Witwatersrand, Johannesburg, South Africa
[4]University of Wyoming, Laramie, USA
[5]Princeton University, Princeton, USA
[6]Wake Forest University, Winston-Salem, USA

Savannas cover a fifth of the Earth's surface and are dominant in Africa where they cover more than a third of the continent. Fire is a dominant form of disturbance in savanna ecosystems, shaping a range of ecological processes, from carbon storage to species interactions to changes in woody cover. A widely held view is that in savannas, and elsewhere, a diversity of fire characteristics in space and time (i.e. pyrodiversity) is thought to result in high levels of heterogeneity, which in turn promotes biodiversity; in other words, that 'pyrodiversity begets biodiversity'. However, while the pyrodiversity-biodiversity hypothesis is intuitively appealing, studies across savanna sites and within other biomes (e.g. mallee woodland in Australia), and across a variety of taxa (e.g. birds, ants, termites, spiders) have found little relationship between pyrodiversity and biodiversity.
I will report on a study which aimed to investigate to what extent pyrodiversity determines mammal and bird diversity across untransformed savanna areas (using protected areas) in Africa. We used a combined value of five fire characteristics: fire return interval, intensity, season, fire size and total area burnt.
We predicted there will be high pyrodiversity at low rainfall but a limited effect on biodiversity because there is little long term change in vegetation structure. Conversely in more mesic areas (e.g. >750mm/yr), although we expected pyrodiversity would be lower, it would have a greater effect on biodiversity because vegetation structure has greater potential for change.

O49-02 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
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Effect of fire on insect interactions in tropical megadiverse mountains

FREDERICO NEVES, FERNANDA COSTA, IVAN MONTEIRO, MATHEUS BELCHIOR, ARLEU VIANA
Universidade Federal de Minas Gerais, Lab. de Ecologia de Insetos/Biologia Geral, 478, Belo Horizonte, Brazil

Fire is a natural phenomenon, but recently its frequency and severity has increased by human activities. Fire acts as an additional component, together with climate and soil, driving vegetation functioning and structure. Among the fire prone ecosystems, the grassy vegetation found in the majority of Brazilian mountains is singular due to its huge biodiversity and long fire history. However, slight attention is given to fire effect on these mountains, especially regarding insects' diversity and their interactions. We investigated how fire affects ant-plant interactions, herbivory association with parasitized plants, and termites-cohabiting diversity in a Brazilian mountain. The study was carried out in Serra do Cipó Minas Gerais, Brazil. In order to verify fire effect on insects' diversity and interactions, the sampling methods were: i) characterize ant-plant interaction through direct observations in trees and shrubs, before and after fire event, ii) measure leaf herbivory in parasitized and not parasitized plants, sampled before and after fire, and iii) sample termite nests in burned and unburned sites. We found that the structure of ant-plant interactions changed right after fire event, but it has reestablished six months later. However the core of highly connected ant species remained the same over time. Fire did not affect herbivory rates in parasitized or unparasitized trees, but it has increased mortality of parasitized plants. Similarly, richness and abundance of termites did not change between burned and unburned sites. Fire is recognized as a strong disturbance in open vegetation. However, our results indicate that insect fauna and its partners in Brazilian grassy environments tend to experience few effects of fire or even be resilient to them. We acknowledge that long term studies on fire frequency and its effects are important to understand the role of fire on ecosystem functioning and promote further conservation strategies. Funding: CNPq, Capes, Fapemig, PELD-CRSC.

O49-03 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
Wednesday 22 June / 16:00-17:30 – Rondelet

A meta-analysis of the effects of fire disturbance on ant abundance and diversity

HERALDO VASCONCELOS[1], JONAS MARAVALHAS[1], TATIANA CORNELISSEN[2]
[1]Univ. Federal de Uberlândia, Instituto de Biologia, 38405-320, Uberlândia, Brazil
[2]Univ. Federal de São João Del Rey, Depto Ciências Naturais, 36307-352, São João Del Rey, Brazil

We conducted a meta-analysis of the effects of fire on the abundance and alpha diversity of ants based upon data published over the past 70 years. Overall, fire reduced ant diversity by 18%, but had no effect on ant abundance. There was no significant differences in mean effect sizes according to the type of fire (wildfire or prescribed), the timing of fire (early or late during the dry season), climate or region. There was significant variation in the effect of fire on ant diversity according to vegetation type and the frequency of fires; fire decreased diversity in forests (but not in other types of vegetation) and in sites where the frequency of fire is low (not moderate to very high). Similarly, fire decreased the diversity and abundance of litter-dwelling ants, but did not influence arboreal and epigaeic ants. A moderately reduction in ant abundance was observed when studies were conducted very shortly after fire (less than 6 months) compared to sampling on longer times after fire. Based on the available data, we found that the global effect of fire on ant assemblages is either weak (on diversity) or non-significant (on abundance). However, reported effects were quite variable among the studies reviewed. Whereas in many studies ants were found to be highly resistant and resilient to fire disturbance, in others the results were opposite. These findings reinforce the idea that it is difficult to draw general conclusions about the effect of fire on biodiversity.

O49-04 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
Wednesday 22 June / 16:00-17:30 – Rondelet

Impacts of fire and fuel loads on ant community structure and their interactions with seeds in AMAZONIAN RAINFOREST

LUCAS PAOLUCCI[1], MARIA MAIA[1], RICARDO SOLAR[1], RICARDO CAMPOS[2], JOSÉ SCHOEREDER[1], ALAN ANDERSEN[3]
[1]Universidade Federal de Viçosa, Programa de Pós-Graduação em Ecologia, Departamento de Biologia Geral, 36570000, Viçosa, Brazil
[2]University of Liverpool, School of Environmental Sciences, L69 3GP, Liverpool, UK
[3]CSIRO Land & Water, Tropical Ecosystems Research Centre, 0822, Darwin, Australia

Fire is a natural phenomenon in savannas, but increasingly human made fires are encroaching on non-flammable systems such as tropical forests. It has been described that human promoted fires are very negative for biodiversity in tropical forests, resulting in substantial mortality of trees and lianas, declines in carbon storage, disruption of plant regeneration process, and the establishment of exotic grass. Also the widespread clearing of tropical forests causes higher and drier fuel loads of forest edges, increasing the risk of fire occurrence and its intensity. Here we used a manipulative field experiment to investigate the influence of fire and fuel loads on ant communities and their interactions with myrmecochorous seeds in the southern Amazon, a region currently undergoing extreme land-use. Experimental fires and fuel addition were applied to 40 x 40 m plots in six replicated blocks, and ants were sampled between 15-30 days after fires in four strata: subterranean, litter, epigaeic, and arboreal. Fire had extensive negative effects on ant communities. Highly specialized cryptobiotic and predator species of the litter layer and epigaeic specialist predators were among the most sensitive, but we did not find evidence of overall biotic homogenization following fire. Fire reduced rates of seed location and transport, and therefore the effectiveness of a key ecosystem service provided by ants, which we attribute to lower ant abundance and increased thermal stress. Experimental fuel addition had only minor effects on attributes of fire severity, and limited effects on ant responses to fire. Our findings indicate that enhanced fuel loads will not decrease ant diversity and ecosystem services through increased fire severity, at least in wetter years. However, higher fuel loads can still have a significant effect on ants from Amazonian rainforests because it decreases ant abundance and increases the risk of fire occurrence, which has a detrimental impact on ant communities and a key ecosystem service they provide. Finally, the results presented here might be used as a baseline for a better understanding about the impacts of fire on shade-adapted fauna, and especially to improve fire management policies in Brazil. Sponsored by CNPq, Capes and Fapemig.

O49-05 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
Wednesday 22 June / 16:00-17:30 – Rondelet

Drought-driven fires and resilience of Amazonian floodplain forests

BERNARDO M. FLORES[1], MILENA HOLMGREN[2], MARTEN SCHEFFER[3]
[1]Wageningen University / Federal University of Rio Grande do Norte, Aquatic Ecology (WUR) / Resource Ecology (WUR) / Department of Ecology (UFRN), NL-6700, Wageningen / Natal, the Netherlands / Brazil
[2]Wageningen University, Resource Ecology Group, NL-6700, Wageningen, the Netherlands
[3]Wageningen University, Aquatic Ecology and Water Quality Management Group, NL-6700, Wageningen, the Netherlands

During the past months, the strongest El Niño event ever recorded has led to severe drought and extensive forest fires in the Amazon and Indonesia. Whether tropical forests will be able to persist in a drier flammable future is uncertain since the mechanisms that drive the transition to a savanna state and the role of landscape heterogeneity remain poorly understood. Here we combine remote sensing, field surveys and field experiments to assess the hypothesis that floodplain forests of the Amazon are less resilient to fire than the surrounding upland terra-firme forests. One-seventh of the Amazon is seasonally flooded. We show that these wetlands have a remarkable susceptibility to drought-driven fires. Our data reveal that fires can trigger major changes in the structure, species composition and soil characteristics of these floodable forests. We found that in repeatedly burnt floodplains, tree seed banks are destroyed, soil nutrients are lost, the recovery capacity of forest structure is slowed down, herbaceous cover increases and there is a persistent colonization of savanna tree species. These changes in the soil and tree species composition suggest a transition from closed canopy forest to open savanna. Our results are consistent with the emerging view that feedbacks between fire, plants and soil contribute not only to maintain, but also to drive shifts between forests and savannas. Insights from these ecosystems indicate that conservation strategies should account for the flammability and unexpected fragility of floodable forests scattered throughout the tropics.

O49-06 – S49 *Fire and biodiversity in the tropics: contrasting savannas and forests*
Wednesday 22 June / 16:00-17:30 – Rondelet

Fire occurrence mediates small-rodent seed removal in neotropical gallery forests inside savanna habitats

CAZETTA THAYSE, VIEIRA EMERSON
Universidade de Brasilia, Departamento de Ecologia, 71910-900, Brasilia, DF, Brazil

Background: Ecological processes can be affected by large-scale disturbances, such as wildfires. In addition to the direct effects (e.g. biomass loss), there are indirect and more subtle effects caused by fire, as a result of changes in environmental characteristics and in densities of predators and potentical dispersers. These indirect effects caused by fire may alter plant-animal interactions, such as dispersal and seed predation. We investigated the relation between fire and small-rodent removal upon seeds of six tree species in Gallery forests from the Brazilian savanna (Cerrado). We expected a reduction in rodent abundance and a consequent reduction in total number of seeds removed in burned areas. The relative role of small rodents as seed removers, however, should increase in such areas, due to a possibly stronger negative effect of fire on larger seed-eating animals.
Method,
We sampled eight forested areas (four burned 2.8 years before and four that had not been burned) located in the same region for evaluation of small-rodent communities (3,789 trapping nights). We also assessed the role of small rodents as seed removers establishing seed-trial stations with two exclusion treatments: semipermeable exclosure (exclusive access of small rodents) and an open control (access of all seed-removing animals) (total of 34 experimental stations per area).
Result: As expected, the average abundance of rodents in the burned forests was reduced to about 1/6 in comparison to the unburned ones and overall seed removal was significantly reduced in fire-disturbed forests for the six species. We found no effects of Treatment (or Fire x Treament) for the seeds of Copaifera langsdorffii, Hymenaea courbaril, and Mauritia flexuosa, indicating that small rodents were the main seed removers regardless the fire occurrence. For Cariniana estrellensis and Dipteryx alata, seeds from open stations were significantly more removed than in exclosures, indicating that others animals than small-rodents also were relevant seed removers. Only for Platypodium elegans, the relative role of small-rodents as seed removers increased after fire, as predicted.
Discussion: Fire seemed to reduce rates of seed removal by small-rodents in Gallery Forests even 2.8 years after the burn. Nevertheless, this disturbance event may reduce rates of seed dispersal by reducing seed removal by potential dispersers and increasing the relative role of small rodents, which act chiefly as seed predators.

O50-01 – S50 *Free session: Methods and metrics to evaluate and measure forest degradation*
Wednesday 22 June / 08:30 - 09:30 – Barthez

Defining forest degradation

JABOURY GHAZOUL
ETH Zurich, Environmental Systems Science, 8092, Zurich, Switzerland

Ecology struggles with poorly defined concepts. Specifically, forest degradation is considered to be an environmental problem of global extent, and yet its definition is problematic. More than 50 different definitions of forest degradation exist, based on various biophysical attributes, but also different perceptions, objectives, and values. Poor or ambiguous definitions lead to misuse, misinterpretation, or, worse, deliberate misinformation. Difficulties include choosing appropriate reference states, time scales, thresholds, and forest values. More generally, forest degradation is considered to be a loss of some attribute, function, or service due to some disturbance. While such an approach might be intuitive, it is not sufficiently precise to distinguish between the many states that forests can occupy. Moreover, such definitions provide few insights into the mechanistic processes that underlie functional degradation and, by extension, trajectories of change and potentials for recovery.
I dispense with many such ambiguities by interpreting forest degradation through the frame of ecological resilience, and with reference to forest dynamics. Specifically, I define forest degradation as a state of anthropogenically-induced arrested succession, where ecological processes that underlie forest dynamics are diminished or severely constrained. Arrested succession implies that management intervention is required to recover successional trajectories. An approach is based on ecological processes of regeneration provides a clear basis for assigning metrics for assessing degradation. These metrics would target traits that reflect species regeneration and community development, and can be developed at the stand or landscape scales.
Such an interpretation of degradation avoids much of the subjectivity and ambiguity associated with many other definitions. Moreover, the definition I propose is well grounded in ecological processes, and can be readily generalised to any forest ecosystem, and can also be extended to other ecosystems.

O50-02 – S50 *Free session: Methods and metrics to evaluate and measure forest degradation*
Wednesday 22 June / 08:30 - 09:30 – Barthez

Experimental defaunation and habitat disturbance influence seed mortality but not seedling establishment

ALYS GRANADOS[1], JEDEDIAH BRODIE[1], HENRY BERNARD[2], MICHAEL O' BRIEN[3]
[1]University of British Columbia, Zoology, V6T 1Z4, Vancouver, Canada
[2]University Malaysia Sabah, Institute for Tropical Biology and Conservation, 88400, Kota Kinabalu, Malaysia
[3]Consejo Superior de Investigaciones Científicas, Estación Experimental de Zonas Áridas, E-04120, Almeria, Spain

Background: Vertebrate granivores destroy plant seeds, but whether this affects plant abundance remains poorly understood, particularly since the importance of seed predation can vary with habitat context, seed traits, and among granivore species. Our incomplete understanding of the full ecological context of seed predation makes it difficult to predict potential cascading impacts of the loss of vertebrate granivores on forest communities.
Methods: We used wire cages to exclude large (elephant), medium (sambar deer, bearded pig, muntjac deer), and small (porcupines, chevrotains) ground-dwelling mammalian granivores in logged and unlogged tropical forests in Sabah, Malaysian Borneo. We assessed the interaction between habitat disturbance (logging) and defaunation on seed germination and seedling establishment in five dominant tree species in the Dipterocarpaceae spanning a 21-fold gradient in seed size. We also quantified the relative abundance of granivores and herbivores in our study area with the use of photographs from camera traps.
Results: Plots that excluded large, medium, and small mammals had lower seed mortality than plots excluding only elephant or control plots to which all animals had access. Granivory-induced seed mortality was higher in logged forest and for small-seeded species. Seed germination was higher in unlogged forest and in plots excluding large, medium, and small mammals. However, establishment probabilities did not differ between logged and unlogged forest. Therefore, mortality at the seed stage due to seed predation did not translate into impacts at the seedling stage.
Conclusion: Many studies of the effects of animals on trees focus on a single life stage. By expanding our focus beyond seeds to even one additional plant stage (seedlings), we found that our understanding of vertebrate impacts on plants changed: animals were important causes of seed mortality, but did not appear to affect seedling establishment. The impacts of disrupted animal-plant interactions due to logging and widespread overhunting must therefore be assessed at multiple plant demographic stages as our findings suggest that the loss of large mammals from tropical forests could have limited repercussions for the regeneration of some dominant trees.

O50-03 – S50 *Free session: Methods and metrics to evaluate and measure forest degradation*
Wednesday 22 June / 08:30 - 09:30 – Barthez

Trophic ecology and functional diversity of terrestrial mammals at Atlantic Forest Hotspot

KATIA FERRAZ[1], MARCELO MAGIOLI[6], DAIANE CARREIRA[6], MAISA ALVES[5], MARIANA LANDIS[5], CAMILA GALVÃO[5], MARCELO MOREIRA[2], MAURO GALETTI[3], FLAVIO GANDARA[4], ELZA FERRAZ[1]
[1]University of São Paulo, Forest Science, 13418900, Piracicaba, Brazil
[2]University of São Paulo, CENA, 13418900, Piracicaba, Brazil
[3]São Paulo State University, Ecology, 05508090, Rio Claro, Brazil
[4]University of São Paulo, Biological Sciences, 13418900, Piracicaba, Brazil
[5]University of São Paulo, Forest Science Graduate Program, 13418900, Piracicaba, Brazil
[6]University of São Paulo, Applied Ecology Graduate Program, 13418900, Piracicaba, Brazil

Considered a global conservation priority, the Atlantic Forest Hotspot contains one of the world's highest biodiversity, high endemism, and also it provides essential ecosystem services for Brazil. Besides that, this biome has being strongly impacted, suffering defaunation processes, with functional losses and consequently, affecting its ecosystem services. Some protected areas located in São Paulo State represent the most important continuous area of Atlantic Forest and one of the last opportunities to study terrestrial mammal ecology. Different methods were used to describe trophic ecology and functional diversity of terrestrial mammals such as camera trapping of focal fruiting species, isotopic analysis of fecal samples and seed germination experiments to investigate the role of terrestrial mammals in this ecosystem. Preliminary results show different patterns of frugivory and seed dispersal among eight focal species sampled. Also, seedling success seems to be dependent of frugivory pattern. Based on 374 km of transect sampling at four protected areas of Atlantic Forest, 152 samples were collected. Community composition varies among them suggesting different trophic structure with possible different ecosystem services provided. We discuss mammal ecological functions (herbivory, seed dispersal and predation) according to landscape structure surrounding sampled areas. The integration of different methods and scales to understand mammal's functional ecology seems to be a powerful approach to improve and accelerate the study of this important hotspot. Financial Support of FAPESP: 2014/09300-0.

O50-04 – S50 *Free session: Methods and metrics to evaluate and measure forest degradation*
Wednesday 22 June / 08:30 - 09:30 – Barthez

Tree inventory data as a valuable tool for IUCN red list assessments

KARINA BANDA[1], JULIA WEINTRITT[1], KYLE DEXTER[2], DARIÉN PRADO[3], TOBY PENNINGTON[1]
[1]Royal Botanic Garden Edinburgh, Tropical Diversity, EH3 5LR, Edinburgh, UK
[2]University of Edinburgh, School of GeoSciences, EH9 3JN, Edinburgh, UK
[3]Universidad Nacional de Rosario, Facultad de Ciencias Agrarias, S2125ZAA, Zavalla, Argentina

Dry forest is highly threatened in the Neotropics and needs urgent conservation. Information on species conservation status and distribution provide the foundation for making informed conservation decisions. The International Union for Conservation of Nature (IUCN) Red list is a commonly used conservation tool which underpins priority setting processes for single species and entire ecosystems. IUCN Red List assessment includes a set of expert-reviewed data on species distribution, population trends, and threats; and a qualified application of IUCN agreed on Categories and Criteria.
DRYFLOR is a network that has developed a floristic database for more than 1600 tree species inventories in dry forests across Latin America and the Caribbean. The aim of this study is to assess the value of the DRYFLOR data for assessing the species conservation status. We evaluated that with a case study, conducting a regional IUCN assessment for 190 tree species from the Andean Piedmont dry forest. The evaluation was done using i) inventory data (DRYFLOR) ii) herbarium records (GBIF) and iii) combined inventory and herbarium records to estimate extents of occurrence (EOO) and area of extension (AOE). These two parameters were calculated using a mapping tool developed directly by DRYFLOR and GeoCAT (interface from Kew Botanic Gardens).
We calculated the parameters of extinction risk for 170 species using GBIF data and 138 using DRYFLOR data. We found that EOO and AOO values calculated from DRYFLOR and GBIF are dissimilar (Wilcoxon sign-rank test AOE: $V = 1547.5$, p-value $< 2.2e-16$; EOO: $V = 1083$, p-value $< 2.2e-16$), indicating that these data sources may provide complementary information. Combining inventory and herbarium records the number of species for which we have sufficient information to make conservation assessments increases by 30 %.
The IUCN is increasingly integrating spatial databases of species that expand the cover of conservation assessments, including the use of species distribution modelling (SDM). The use of empirical data from ecological inventories is a valuable alternative approach, which does not run the risk of over-prediction of species distributions, as is sometimes the case with SDMs. Here, we demonstrate the importance of ecological inventory data as a complementary data source in conservation assessment for dry forest trees in the Andean Piedmont. We will discuss whether these results are general for other areas of dry forest in the Neotropics.

O51-01 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Camera trapping of tropical mammal communities: introduction to the symposium

PATRICK A. JANSEN[1], J. MARCUS ROWCLIFFE[2], CHRIS CARBONE[2]
[1]Smithsonian Tropical Research Institute, Center for Tropical Forest Science, 0843-03092, Balboa, Ancon, Panama
[2]Zoological Society of London, Institute of Zoology, NW1 4RY, London, United Kingdom

Camera traps have a long history of use in studies of mammal species in tropical forests, where densities tend to be low and habits nocturnal, and distance sampling is difficult. Most camera-trapping studies focused on species that can be individually recognized by patterns in their fur, such as jaguars and tigers, and are suitable for the use of traditional mark-recapture techniques. Camera traps have also been widely used to generate simple species richness estimates.
Here, we introduce a symposium on the more recent use of camera traps for studying tropical mammal communities, a field for which analytical methods are undergoing rapid development. A major challenge in these studies is that individual recognition is often impossible, hence inferences on abundance must come from photographic rates or detection histories. This comes with complications, because the rate at which a species is photographed depends on many factors other than abundance, and that this dependence differs between species and circumstances in unknown ways.
Among others, we will explain how animal body mass, ambient temperature and humidity, and vegetation density influence the distance over which camera traps with passive infrared sensors detect animals, and how activity level and movement speed influence the likelihood of animals encountering camera traps, so that photographic rates are not simply proportional to animal abundance.
The speakers in this symposium will each present different methods for addressing community questions with camera traps, illustrated by case studies of mammal communities in tropical forest. The talks illustrate a range of approaches to controlling for detectability. Together, the talks will help to decide which approaches are best suited to particular situations/questions, and how much correction for differences in detectability really matters.

O51-02 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Activity of terrestrial mammals in the Tamshiyacu Tahuayo communal reserve, northeastern Peru

NEREYDA FALCONI[1], NEREYDA FALCONI[2]
[1]Wildlife Conservation Society, Peru, Lima18, Lima, Peru
[2]University of Massachusetts Amherst, Environmental Conservation, 01002, Amherst, Unites Stated

Background: We used camera trapping at Tamshiyacu Tahuayo communal reserve to assess the activity of terrestrial mammals in a zone were the community regulate hunting. We specifically evaluated the activity patterns and overlap of activity periods between predator and prey species to gain insight on the strategies that mammals use to avoid predation.
Methods: We installed camera traps in 50 out of the 84 one Km^2 grid cell points established randomly in the communal reserve area to monitor terrestrial mammals. One camera trap was installed within each of the 50 one Km^2. These cameras were active for a two-month period and were placed in areas with increased probability of detection such as animal trails, mineral licks, and areas with high track density.
Results: We obtained 1346 captures representing 19 species in 3191 camera days. Tapirus terrestris (n=156 cpatures) and Cuniculus paca (n=220) showed nocturnal activity. Mazama nemorivaga (n=53), Tayassu pecari (n=16), Pecari tajacu (n=149) and Dasyprocta fuliginosa (n=299) showed diurnal activity. Mazama americana (n=151), Panthera onca (n= 13) and Leopardus pardalis (n=12) didn't show a clear activity pattern and registered activity along day and night. Leopardus pardalis presented a high activity overlap with important prey species such as C. paca (65% overlap) and D. fuliginosa (41% overlap). Similarly, P. onca showed high activity overlap with T. terrestris (71% overlap), M. Americana (69% overlap), M. nemorivaga (45% overlap), T. pecari (40% overlap), and P. tajacu (42% overlap).
Discussion and Conclusion: We found that L. pardalis was active both during day and night, matching the activity pattern of its main prey species: C. paca (nocturnal) and D. fuliginosa (diurnal). Higher activity overlap with C. paca than with D. fuliginosa may be due to preference for C. paca. Panthera onca was also active along the day and night where main prey species were active, showing the largest activity overlap with T. terrestris and less overlap with M. nemorivaga. Our study shows that the Tamshiyacu Tahuayo communal reserve contains a diverse assembly of predator and prey species that ought to be preserved. Therefore, the active management of hunting by the local community seems to have worked so far in the conservation of most vulnerable species such as T. terrestris. However, further studies are needed to assess the activity interactions of other predators like Puma concolor which is also present in the site.

O51-03 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Body size scaling of photographic detection and its implications for biodiversity surveys

CARBONE CHRISTOPHER
Institute of Zoology, Zoological Society of London, NW1 4RY, London, UK

Body size influences many aspects of species biology often linked with its influence on energy demands. Among terrestrial mammals, size influences speed of movement, activity patterns and perhaps most importantly for photographic surveys, the effective angle of detection and distance of detection. Combined these factors could lead to vastly different photographic rates across different sized species irrespective of their densities. While many might argue that this provides further evidence undermining the use of naïve trapping rates or RAIs as a method of obtaining abundance indices, methods, which explicitly model these size-related factors (e.g.Random Encounter Model (REM) method) may provide opportunities to correct for size related biases across studies. Here I explore the potential for generalizing REM metrics to produce a size-corrected relative abundance indices scRAI's, which may have important implications for both improving abundance indices and retrospectively analysing past camera-trapping studies.

O51-04 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Effectiveness of Protected Areas for biodiversity conservation: mammal occupancy patterns in the Iguaçu National Park

MARINA XAVIER DA SILVA[1], LEANDRO REVERBERI TAMBOSI[2], RENATA PARDINI[2]
[1]Parque Nacional do Iguaçu, Projeto Carnívoros do Iguaçu, 85855-750, Foz do Iguaçu, Brazil
[2]Universidade de São Paulo, Instituto de Biociências, 05508-090, São Paulo, Brazil

Background: Protected areas are widely recognized as the main strategy for biodiversity conservation, with the global system covering 12% of the planet. Despite the importance of evaluating the effectiveness of these areas, most studies albeit focusing on global/ regional scales did not include information on biodiversity. This detailed information is particularly urgent in countries as Brazil that harbors the largest protected area systems and in biomes such as the Atlantic Forest where protected areas are forest islands within human-modified landscapes. We here focus on the Iguaçu National Park – one of the largest Atlantic Forest protected areas and considered one of the best managed parks in Brazil - and on terrestrial large mammals as a case study to evaluate the effectiveness of protected areas in conserving biodiversity.
Methods: We monitored 300 km^2 with 37 cameras traps arranged every 4 km in 9 1-month sessions during five years. Using occupancy models, we evaluated if hunting records, proximity to tourism attractions and proximity to the edge of the park affect species distribution. We extrapolated occupancy to the entire park using the best model for each species, standardized occupancy values so that for all species occupancy varied from 0 to 1, and then calculated the mean occupancy among species in each 100-m2 cell of the park. From this map, we built a histogram of the area of the park presenting different classes of mean occupancy.
Results: Many species that are locally extinct in most Atlantic Forest remnants are present in the park; however, the selected models indicate that at least one of the studied factors affected the distribution of 11 among 16 analyzed species. In 50% of the park, species have in average occupancy smaller than 85% of the maximum value, and in no area of the park species have in average occupancies large than 92.5% of the maximum value.
Conclusions: In a considerable area of the park species occupancy is lowered given the effects mainly of proximity to touristic attractions and to the edge of the park. These negative effects are expected to be even stronger on smaller protected areas, which are the majority in altered biomes such as the Atlantic Forest. Re-establishing and properly managing buffer zones, restricting tourism to localized areas, combating illicit activities and reducing human-wildlife conflicts are essential to ensure the effectiveness of protected areas for biodiversity conservation.

O51-05 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

The importance of considering more than one variable group in occupancy analyses: a case study

GABRIEL PENIDO[1], SAMUEL ASTETE[1], RAHEL SOLLMANN[2], ANAH JACOMO[3], NATALIA TORRES[3], LEANDRO SILVEIRA[3], JADER JADER[4]
[1]Universidade de Brasilia, Departamento de Ecologia, 70910-900, Brasília, Brazil
[2]US Forest Service, Pacific Southwest Research Station, 95618, Davis, US
[3]Jaguar Conservation Fund, 75830-000, Mineiros, Brazil
[4]Universidade de Brasilia, Departamento de Zoologia, 75830-000, Brasilia, Brazil

Species distribution is a key concept in ecology. Understanding the rules and factors that affect these patterns is essential to devise conservation programs not only for singular species, but in the case of carnivores, for the entire ecosystem. Many studies addressed carnivore spatial distributions identifying different variables affecting their occupancy in different places. However, most studies considered only one set of variables, which might had led to inaccurate conclusions about their distribution. Here, we estimated distribution patterns of the ocelot in a semiarid landscape in Brazil. We selected three potential sources of variation on ocelot's occupancy: environmental characteristics, apex predators and potential prey distribution. This way, we could build a more broad perception of which factors might play a role in this carnivore distribution, while avoiding erroneous conclusions with limited variable sets.
We deployed 58 camera-traps on roads in a National Park in northeastern Brazil. We considered altitude, temperature and number of water sources near each camera as environmental variables, jaguar and puma presence as apex predators and rodent and armadillo species records as potential prey. We developed and analyzed models for each variable set individually and together in a single global model that contained all variables. Thus, we could compare the results from individual models sets with the complete global model. All occupancy analysis were done in software R (3.1.2) with package Unmarked. Models were selected by the AIC.
Considering each variable group individually, we found that for environmental characteristics ocelot's occupancy was constant and its detection was higher in lower altitudes; Jaguar affected negatively ocelot occurrence in the apex predator model set; and in the prey set, the presence of rodent was positively related to ocelot occupancy. The global set showed that models that best fitted the data included rodents and jaguar effects on ocelot's occupancy and altitude in its detection.
This study shows that if we consider only one group of variables we may find inaccurate results. If we analyzed only one set, we could have concluded that nothing may be affecting ocelot occurrence or that the presence of jaguar or rodents are the main factor, while the best fitted model included variables from all three sets. Only by constructing a more comprehensive model, we can get a better understanding of a species distribution.

O51-06 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Temporal sensitivity of the Wildlife Picture Index as an indicator for changes in communities of ground-dwelling terrestrial vertebrates sampled with camera traps

JORGE AHUMADA[1], LYDIA BEAUDROT[2], PATRICK JANSEN[3], TIM O'BRIEN[4]
[1]Conservation International, Moore Center for Science, 22202, Arlington, USA
[2]University of Michigan, Department of Ecology and Evolutionary Biology, 48103, Ann Arbor, USA
[3]Wageningen University, Department of Environmental Science, 00, Wageningen, Netherlands
[4]Wildlife Conservation Society, Senior Scientist, 10460, New York, USA

There is a need in the scientific and conservation world to understand better how and why wildlife populations are changing, specially in ecosystems that are threatened and where there are large knoweldge gaps (e.g. tropical forests). Camera traps and other automated sensors are helping us collect large amounts of information on wildlife, but indicators of change derived from these data remained poorly understood. The Wildlife Picture Index (WPI) is a promising and flexible indicator that measures changes in biodiversity using camera trap data, but relatively little work has been done on its sensitivity to detect change. In this talk, we examine the temporal sensitivity and statistical power of the Wildlife Picture Index (WPI), under different scenarios of sampling effort and temporal dynamics of the underlying species. Using a dynamic occupancy model we simulate changes in 1, 3, 5, 10, and 15% in occupancy of 25 species and under different sampling effort (30,60, 90, 120 points leaving each point for 10, 15, 30, 45 and 60 days in the field) and different mixtures of species (all declining, half declining, a third declining, a fifth declining). Under each of these scenarios we calculate the WPI and test whether it recovers the underlying dynamics of the community. We apply this knowledge to the real analysis of multi-year and multi-species data coming from the TEAM network. We show that the index is sensitive to at least 5% occupancy of the underlying species when most species are declining in the community.

O51-07 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Random encounter modelling for multi-species density estimation from single camera surveys

MARCUS ROWCLIFFE[1], ROLAND KAYS[2], BART KRANSTAUBER[3], CHRIS CARBONE[4], PATRICK JANSEN[1]
[1]ZSL, Institute of Zoology, NW1 4RY, London, UK
[2]North Carolina State University and Museum of Natural Sciences, NA, NA, Raleigh, USA
[3]Max Planck Institute for Ornithology, Department of Migration and Immuno-Ecology, NA, Radolfzell, Germany
[4]Wageningen University, Department of Environmental Sciences, NA, Wageningen, Netherlands

Camera traps are widely and increasingly used to infer spatio-temporal patterns of relative abundance for a wide range of terrestrial mammals, with important implications for effective tropical ecology and conservation. Surveys generate information on multiple species, but extracting signals of abundance that are comparable across time, space and species is problematic because detectabilities vary greatly in these dimensions. Random encounter modelling (REM) and a related approach, non-instantaneous plot sampling (NIPS), offer possible approaches for detectability-corrected density estimation that are relatively simple analytically, but have not yet emerged as fully fledged tools for density estimation. This presentation will outline these approaches and evaluate their potential for application, considering survey design requirements, sample size constraints, practical considerations for data generation, potential sources of bias, and finally the levels of accuracy and species coverage that can be achieved in practice for multi-species tropical mammal surveys.

O51-08 – S51 *Pattern and process in tropical mammal communities: a camera trapping perspective*
Wednesday 22 June / 10:00-12:00 – Barthez

Multi-species modelling using camera traps: challenges and opportunities

OLIVER WEARN[1], MARCUS ROWCLIFFE[2], CHRIS CARBONE[3], MARION PFEIFER[4], HENRY BERNARD[5], ROBERT EWERS[6]
[1]Zoological Society of London, Institute of Zoology, NW1 4RY, London, UK
[2]Zoological Society of London, Institute of Zoology, NW1 4RY, London, UK
[3]Zoological Society of London, Institute of Zoology, NW1 4RY, London, UK
[4]Imperial College London, Department of Life Science, SL5 7PY, Ascot, UK
[5]Universiti Malaysia Sabah, Institute for Tropical Biology and Conservation, 88400, Kota Kinabalu, Malaysia
[6]Imperial College London, Department of Life Science, SL5 7PY, Ascot, UK

The camera trap is now a familiar tool for wildlife biologists across the globe, operating in all terrestrial environments and catching a wide variety of warm-blooded species. Until recently, though, most camera surveys have routinely discarded wildlife. "By-catch" species, typically those that do not have stripes or spots, may be "thrown back" either at the image cataloguing or analysis stage. New statistical tools, however, increasingly allow for robust inferences to be made about such species.
In this talk, I consider a ban on discards. I will discuss the opportunities, and challenges, of hierarchical multi-species modelling of whole communities, with reference to a large dataset collected on the island of Borneo. We deployed cameras and live traps over the course of 3 years in a clustered design, to assess mammalian community structure across a gradient of land-use intensity (primary forest, logged forest and oil palm plantations). This allowed us to simultaneously monitor ~60 species of large and small mammal across the gradient, and begin to explore how the coarse- and fine-scale structure of terrestrial mammal communities is altered by changes in land-use. At the coarse community scale, we found a remarkable overall resilience to selective logging, but fine-scale dissection of the community highlighted particular groups (e.g. frugivores) and particular species (e.g. the banded civet, Hemigalus derbyanus) which do not respond favourably. Oil palm, on the other hand, exhibited a severely depauperate mammal community, with only a handful of species (some carnivores, and invasives) prospering. Hierarchical multi-species modelling was analytically and computationally-intensive, but ultimately allowed for a more comprehensive understanding of community responses.

O52-01 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Landscape connectivity for the Asian elephant in its largest remaining subpopulation and regional planning

JEAN-PHILIPPE PUYRAVAUD[1], SAMUEL CUSHMAN[2], PRIYA DAVIDAR[3], DEEPAK MAPAPPA[3]
[1]Sigur Nature Trust, Conservation, 643223, Masinagudi, India
[2]USDA Forest Service, Rocky Mountain Research Station, 86001, Flagstaff, USA
[3]Pondicherry University, Department of Ecology and Environmental Sciences, 605014, Puducherry, India

The Nilgiri Biosphere Reserve (southern India) supports the largest remaining population of the endangered Asian elephant and other megafauna, such as the Bengal tiger. This reserve is also the center of a population connectivity network that links the Western and Eastern Ghats, two mountain ranges of major conservation value in peninsular India, increasingly threatened by development. Most projects are implemented with no possibility to check their impact on connectivity because current understanding of connectivity is based on expert opinion. To evaluate population connectivity for the Asian elephant we built a movement resistance model based on the combined contributions of land cover, topographical slope, elevation, roads and human habitations. We utilized a spatially explicit connectivity modeling tool to predict optimal movement corridors as a function of factorial least cost routes across the resistance map. We used a resistant kernel approach to produce a map of the expected frequency of elephant movement through each cell to define core areas. We evaluated the optimality of expert corridors by using a path randomization method. Expert teams agreed on less than 20% of the corridors whereas more than half of the expert corridors detected by the model had connectivity values significantly higher than expected by chance. The agreement between our model and individual expert teams was consequently much higher than that of expert teams among themselves. Corridors with the highest connectivity corresponded with priority areas identified by other conservationists and elephant density predicted by the resistant kernel connectivity model correlated significantly with surveys (Spearman rho = 0.85, n = 500, $p << 0.001$). Our results provide the first rigorous, spatially synoptic and empirically validated evaluation of the connectivity for enabling elephant movement across the reserve. The study offers a base-line understanding of elephant population connectivity, prioritizes corridors thereby enabling decision maker to utilize maps to see how development will affect elephant movement. It also show that the southern part of the Nilgiri Biosphere Reserve remains relatively isolated because of development, topographical constraints and lower levels of protection.

O52-02 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Forced neighbors: co-existence between jaguars and pumas in the semi-arid Caatinga biome of Brazil

SAMUEL ASTETE[1], JADER MARINHO-FILHO[2], MAJA KAJIN[3], GABRIEL PENIDO[4], BÁRBARA ZIMBRES[5], RAHEL SOLLMANN[6]
[1]Universidade de Brasília, Departamento de Zoologia, 70910-900, Brasília, Brazil
[2]Universidade de Brasília, Departamento de Zoologia, 70910-900, Brasília, Brazil
[3]Universidade do Estado do Rio de Janeiro, Departamento de Ecologia, 20559-900, Rio de Janeiro, Brazil
[4]Universidade de Brasília, Programa de Pós-Graduação em Ecologia, 70910-900, Brasília, Brazil
[5]Universidade de Brasília, Programa de Pós-Graduação em Zoologia, 70910-900, Brasília, Brazil
[6]US Forest Service, Pacific Southwest Research Station, CA 95618, Davis, United States
[7]Jaguar Conservation Fund, Conselho Gestor, 75830-000, Mineiros, Brazil
[8]Universidade Federal de Uberlândia, Instituto de Biologia, 38408-100, Uberlândia, Brazil
[9]Jaguar Conservation Fund, Conselho Diretor, 75830-000, Mineiros, Brazil

Background: Carnivores face conflicts with humans for land and food, which has reduced their numbers and distribution. Carnivores also compete between themselves in intraguild predation systems, in which the coexistence is a rare case, because the system tends for the prevalence of the dominant or the subordinate predator. Coexistence requires a complex combination of resources, environmental conditions and appropriate numbers of the top predator. In this study we assessed the occupancy of two predators, the jaguar (Panthera onca) and the puma (Puma concolor) in the Serra da Capivara National Park (SCNP), a protected area in the semi-arid Caatinga biome of Brazil. Felines are a group of carnivores which face biological limitations in hot environments.
Method: Between 2009 and 2011 we used camera-traps and multi-species single-season occupancy models to evaluate the patterns of habitat use in SCNP. We modeled the response of detection probability and occupancy with covariates for each point, such as distance to towns, distance to water sources, altitude, total biomass of prey. We also used camera-traps to analyze the species' activity patterns and their interactions. We considered the jaguar as dominant predator and puma as subordinate, and expected to find evidence of spatial and temporal avoidance between them.
Result: We found evidences of spatial and temporal coexistence between jaguars and pumas. The results of the Occupancy analysis showed a Species Interaction Factor (SIF) over than one, which means that species co-occurr more often than expected. Occupancy of jaguar and puma was most explained by the altitude covariate, followed by the biomass index. Overlap in the activities of these species was very high, without a clear indication of segregation in activity.
Discussion: This co-existence could be a result of several factors, such as the combination of extreme temperatures and the scarcity of refuges to thermoregulate during the daytime with extremely high temperatures for felines. This could also explain the preference for altitude, especially regions of canyons and natural refuges. The lack of activity during the day due high temperatures can also explain the high overlap of nocturnal activity by both species. The inclusion of the Biomass Index as a preferred covariate could be explained due an apparently increase of the base of prey along time in SCNP, a consequence of the conservation and management politics applied in the Park since 1994.

O52-03 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Identifying sources of lead in Amazonian wildlife by lead isotope analysis

MAR CARTRÓ-SABATÉ[1], PEDRO MAYOR APARICIO[2], ANTONI ROSELL-MELÉ[3], MARTÍ ORTA-MARTÍNEZ[4]
[1]Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, 08193, Bellaterra, Spain
[2]Dept. Sanitat i Anatomia Animals, Universitat Autònoma de Barcelona, 08193, Bellaterra, Spain
[3]Institució Catalana de Recerca i Estudis Avançats, Universitat Autònoma de Barcelona, 08010, Barcelona, Spain
[4]International Institute of Social Studies, Erasmus University Rotterdam, Erasmus University Rotterdam, 2518 AX, The Hague, The Netherlands

The first barrels of oil extracted from the northern Peruvian Amazon were obtained in the early 1970s. Hydrocarbon concessions have been spread across the territory, and 70% of the Peruvian tropical rainforests have been leased at some point between 1970-2009. Although there is a dearth of scientific studies, a number of governmental studies have been shown a bothering presence of heavy metals and hydrocarbons in the physical environment and human communities in the area.
According to the indigenous inhabitants of the oil concession, game species frequently visit oil spills to ingest oil-polluted soil. Our hypothesis is that game species frequent these sites attracted by salts that usually accompanied oil spills. Some heavy metals and polycyclic aromatic hydrocarbons usually found in these dumping sites are persistent and toxic and may climb through the food chain affecting the whole ecosystem and the local human populations that rely on subsistence hunting.
We have already collected visual evidences of this phenomenon through a camera trap program. This paper presents our results on the assimilation and bioaccumulation of oil contaminants by game species in the study area. We have conducted heavy metals analysis of soil samples and of game animal livers collected in the study area, as well as in control areas that have never been affected by hydrocarbon activities.
A lead isotopic fingerprint analysis shows that control livers samples share the same sole source of lead, that we assume to be lead naturally present in soils. Livers samples from the oil concession also have another source of lead: oil spills are a relevant contributor of lead in the livers of game species inside the oil concession.
Taking into account that up to 30% of the world's rainforests overlap with hydrocarbon reserves our results may be very relevant to evaluate the impacts of the oil industry on wildlife and public health for the whole Amazon and beyond.

O52-04 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Rapid Inventories, Museum Science, and Conservation in Loreto, Peru

CORINE VRIESENDORP, DIANA ALVIRA, ALVARO DEL CAMPO, ROBIN FOSTER, DEBRA MOSKOVITS, MARIO PARIONA, NIGEL PITMAN, DOUGLAS STOTZ, TYANA WACHTER, ALAKA WALI
The Field Museum, Science & Education, 60605, Chicago, USA

Tropical governments face growing interest and intense lobbying from extractive industries and monoculture projects (e.g., timber, mining, petroleum, oil palm plantations). As a counterbalance, The Field Museum has made a concentrated effort from 2001-2014 to put conservation science into the hands of decision-makers. Together with 51 distinct Peruvian partners and 164 Amazonian experts we have conducted 14 rapid biological and social inventories in Loreto, northern Peru. Covering about 370,000 sq. km., Loreto is at the intersection of enormous geological, biological, and cultural diversity in the upper Amazon basin. Our inventories have uncovered more than 180 new species to science and extended the known ranges of thousands of plant and animal species. We documented the organizational strengths, natural resource use, and conservation vision of 150 local communities to identify ways to engage local residents in long-term conservation. To date, our integrated recommendations have helped Peruvian officials declare 11 new conservation areas in northern Peru for a total of 6.89 million hectares, including three national parks (Cordillera Azul, Güeppí-Sekime, Sierra del Divisor), two communal reserves (Airo Pai, Huimeki), one national reserve (Matsés), one reserved zone (Yaguas), and four regional conservation areas (Tamshiyacu-Tahuayo, Ampiyacu-Apayacu, Nanay-Pintuyacu-Chambira, Maijuna). In 2001, there were 4 conservation areas in Loreto, covering 8.4% of its land area. In 2012, there are now 16 conservation landscapes (including 12 rapid inventory sites) covering 23.8% of Loreto, one of the most diverse places on the planet. This sort of conservation impact illustrates one of the ways that 21st century natural history museums can fill an important niche in the conservation landscape.

O52-05 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Physical and chemical defenses in tropical pioneer seeds: trade-offs and seed defense syndromes

PAUL-CAMILO ZALAMEA[1], CAROLINA SARMIENTO[1], CAROLYN DELEVICH[1], ANYANGATIA NDOBEGANG[2], MARK A. BERHOW[3], ADAM S. DAVIS[4], A. ELIZABETH ARNOLD[2], JAMES W. DALLING[5]
[1]Smithsonian Tropical Research Institute, BCI, 000, Panama, Panama
[2]University of Arizona, School of Plant Sciences, 85721, Tucson, AZ, USA
[3]USDA, National Center of Agricultural Utilization Research, 61601, Peoria, IL, USA
[4]USDA, Agricultural Research Service, 61801, Urbana, IL, USA
[5]University of Illinois at Urbana-Champaign, Department of Plant Biology, 61801, Urbana, IL, USA

Seeds of tropical tree species have multiple chemical and physical characteristics that determine their propensity to form a persistent soil seed bank. These traits can allow seeds to survive in the soil despite an array of predators and pathogens, and to germinate and recruit even decades after seed dispersal. Here we evaluated whether classes of seed defenses were negatively correlated within species (consistent with trade-offs in defense strategies), or whether traits formed associations across species (consistent with seed defense syndromes). We collected a dataset from seeds of 15 of the most common pioneer tree species in neotropical forests to investigate the relationships among four physical and two chemical defense traits, and their association with seed persistence. We combined trait analyses with toxicity assays in which we measured effects of seed chemistry on fungal growth (Fusarium spp.) and brine shrimp survival (Artemia franciscana). We did not find a direct trade-off between chemical and physical defenses. However, seed permeability was positively associated with chemical defense, and negatively associated with physical defense. Using a linear discriminant analysis we found empirical evidence to distinguish among three distinctive seed defense syndromes (i.e. quiescent, physical and physiological). Brine shrimp survival and hyphal growth was reduced most by extracts with higher concentrations of phenols. Our data suggest that long-term persistence of seeds (>3 years) can be achieved by two suites of traits: by permeable seeds that are well defended chemically, or by impermeable seeds that are well defended physically. Overall, our results do not support the existence of direct trade-offs between physical and chemical defenses in seeds. Instead, we provide empirical evidence for distinguishing among seed defense syndromes that could result from different environmental and evolutionary pressures that together frame combinations of defensive traits to coexisting pioneer tree species.

O52-06 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Biotic homogeneity of biogeographic units in the Neotropics: a test with Sapotaceae

JULIETH SERRANO[1], IVAN JIMENEZ[2], JAMES RICHARDSON[1], DAIRON CARDENAS[3], ALLAN ELLIOT[1], RICHARD MILNE[4], TOBY PENNINGTON[1], TERRY PENNINGTON[5], ROCIO CORTES[6]
[1]Royal Botanic Garden Edinburgh, Tropical, EH3 5LR, Edinburgh, United Kingdom
[2]Missouri Botanical Garden, Center for Conservation and Sustainable Development, 63166-0299, Missouri, United States
[3]Instituto Amazónico de Investigaciones Científicas SINCHI, Ecosistemas y recursos naturales, NA, Bogota, Colombia
[4]University of Edinburgh, Biological Sciences, EH8 9YL, Edinburgh, United Kingdom
[5]Royal Botanic Gardens, Kew, Herbarium, TW9 3AB, London, United Kingdom
[6]Universidad Distrital Francisco José de Caldas, Herbarium, NA, Bogota, Colombia

A central tenet of biogeography is that organisms are distributed across geographic space in a non-random fashion, forming spatial aggregations of endemic taxa with overlapping distributions, a phenomenon known as provincialism. At least since the nineteenth century provincialism has been described by drawing divisions of Earth thought to reflect patterns of biotic similarity, thus delimiting areas heralded as "biogeographic units."
A key prediction implicit in proposed biogeographic regionalizations is the biotic homogeneity of putative biogeographic units. In particular, if putative biogeographic units accurately describe the spatial aggregation of endemic taxa (i.e. provincialism), then biotas should be more homogeneous within than among putative biogeographic units. Despite its significance for basic science and biodiversity conservation, studies that explicitly examine the biotic homogeneity of putative biogeographic units seem scarce.
Here we view the Neotropical biogeographic units proposed by Morrone (2001) as working hypotheses, and focus on testing if they are homogeneous in terms of one component of the biota: plant species in the family Sapotaceae. Specifically, we tested if variation in species composition (beta-diversity) within biogeographic units was lower than across biogeographic units, while controlling for potential confounding effects of geographic distance and heterogeneous botanical sampling effort.
Our results suggest that none the biogeographic units proposed by Morrone (2001) are biotically homogenous compared with all of the other units used in the analyses; however, homogeneity at short geographic distances in provinces and subregions, and biotic distinctiveness of several provinces was evident.
The analyses performed in this study and its results are specific to a representative taxon in the area of interest, and to the biogeographic regionalization proposed by Morrone (2001). However, the statistical framework and key assumption of testing biotic homogeneity of putative biogeographic units can be replicated to several scenarios. This could provide tools to define limits within biogeographic regionalizations. Moreover, it could play significant roles in attempts to uncover the history and current spatial structure of life on earth, and in plans for the conservation and management of biological diversity.

O52-07 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Behavioral response of flower-visiting hummingbirds to sit-and-wait predators

CHRISTIAN H. SCHULZE, NICOLAS R. DABITZ, MATHIAS FLIEDER, TANJA POLLERES, STEFANIE WIMMER
University of Vienna, Division of Tropical Ecology and Biodiversity Research, Department of Botany and Biodiversity Research, 1030, Vienna, Austria

Background: Animals depending on sources such as flowers, which they visit regularly for exploiting nectar are an attractive prey for sit-and-wait predators. In this study we evaluated experimentally if hummingbirds perceive sit-and-wait predators such as snakes and larger preying mantids hiding in close vicinity to nectar-producing flowers as potential predation risk. So far only anecdotal records of hummingbirds caught by these predators are reported indicating that such events occur very infrequently. However, even such rare predation events may dramatically decrease the life-time reproduction and hence the fitness of hummingbirds, consequently representing an important selective force driving the evolution of vigilance behavior and skills to recognize and detect such predators.
Methods: During experiments conducted in the surroundings of the Tropical Research Station La Gamba, Costa Rica we used artificial mantids and snakes exposed near flowers which proved to be visited regularly by hummingbirds. We examined if hummingbirds approaching flowers perceive these dummies as potential predation risk. Therefore, we quantified their response by measuring the "predator approaching time" as indirect evidence for the predation risk level. To exclude that birds were only confused by the unfamiliar objects, we additionally used harmless objects (white napkins) for comparison.
Results: Hummingbirds responded strongly to the exposed dummy predators while the napkins were mostly ignored. Overall a much stronger response was triggered by the snakes. However, particularly smaller hummingbirds also reacted strongly towards the mantid dummies. As soon as a dummy predator was detected hummingbirds stopped immediately with their flower visiting behavior but were hovering intensively around the dummy predators with their tail spread.
Discussion: Our experiments provide clear evidence that hummingbirds are able to recognize and respond to both types of sit-and-wait predators. However, the predation risk classification of snakes and mantids differed between hummingbird species. While snakes appear to represent an equal predation risk for all studied hummingbird species, smaller species responded much stronger to mantid dummies than larger hummingbirds, which apparently do not perceive mantids as high-risk predators. These observations indicate that sit-and-wait predators play a so far underestimated role for flower-visiting tropical birds.

O52-08 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Oviposition Behavior of Phorid Parasitoids Attacking Carpenter Ants in the Genus Camponotus

DONALD H. FEENER JR.
University of Utah, Biology, 84112, Salt Lake City, USA

Many ant species in the Neotropics are attacked by specialized parasitoids in the dipteran family Phoridae, including carpenter ants in the genus Camponotus. These parasitoids display two mutually exclusive lifestyles; they either attack live, healthy hosts, which are typically workers running along foraging trails, or they attack injured or moribund solitary workers found in the environment away from their nest site. Parasitoids with the first lifestyle oviposit in hosts while in flight, whereas parasitoids with the second lifestyle usually stand on the host during oviposition. In Costa Rica, Panama and Brazil, several species of parasitoids are attracted to injured workers of the carpenter ant Camponotus sericeiventris. In my presentation, I present video evidence of the highly specialized oviposition behavior of three species of these parasitoids. Females of Rhyncophoromyia trivittata stand on the head of the injured ant and oviposit through the suture where the base of the antennal scape is attached to the head. Females of Rhyncophoromyia maculineura stand on the abdomen of the injured ant and lay eggs through the intersegmental membrane between the abdominal sclerites. Females of an as yet undescribed species of Diocophora oviposit eggs into the femur through its joint with the tibia while standing on the leg of the injured worker. Once at an injured worker, a single female of Diocophora will often fly or walk from leg to leg and lay an egg in each. In experiments where I have injured workers by crushing their thorax it is not unusual to attract multiple individuals of all three species of parasitoids and for mature larvae of more than one species to emerge from a single worker. I have occasionally observed still other species oviposit in injured workers of C. sericeiventris, one into the head through the foramen and another into the thorax through a thoracic suture. Preliminary studies suggest that injured workers other large neotropical Camponotus are frequently attacked by similar parasitoids, but we do not yet know how specialized these species are. The genera Rhyncophoromyia and Diocophora are also found in the Nearctic, which suggest that temperate zone species of Camponotus may also be attacked by these parasitoids. I conclude with some questions about the diversification of these parasitoids.

O52-09 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

Introducing tropical liana proliferation in a vegetation model

VERBEECK HANS, DE DEURWAERDER HANNES, DI PORCIA E BRUGNERA MANFREDO, MOORTHY SRUTHI, PAUSENBERGER NANCY, ROELS JANA, KEARSLEY ELIZABETH
Ghent University, CAVElab Computational and Apllied Vegetation Ecology, 9000, Gent, Belgium

Tropical forests are essential components of the earth system and play a critical role in land surface feedbacks to climate change. These forests are currently experiencing large-scale structural changes, including the increase of liana abundance and biomass. This liana proliferation introduces a major shift in floristic composition and might have large impacts on the carbon cycle of tropical forests. However no single global vegetation model currently accounts for lianas.
The TREECLIMBERS project (ERC starting grant) aims to introduce for the first time lianas into a vegetation model. The project attempts to reach this challenging goal by performing a global meta-analysis on liana data and by collecting new data in South American forests. Those new and existing datasets form the basis of a new liana plant functional type (PFT) that is currently included in the Ecosystem Demography model (ED2).
This presentation will show an overview of the current progress of the TREECLIMBERS project. Liana inventory data collected in French Guiana along a forest disturbance gradient show the relation between liana abundance and disturbance. Xylem water isotope analysis indicates that trees and lianas can rely on different soil water resources. New modelling concepts for liana PFTs will be presented and in-situ leaf gas exchange and sap flow data are used to parameterize water and carbon fluxes for this new PFT. Finally terrestrial LiDAR observations in a large liana removal experiment in Panama will be highlighted.

O52-10 – S52 *Free Session: Tropical ecology*
Wednesday 22 June / 14:30-17:30 – Barthez

What is the relative importance of physical, biological environment and geographic distance in shaping medium and large fauna assemblages in lowland Amazonia?

THOMAS DENIS[1], BRUNO HÉRAULT[2], GUIET STÉPHANE[3], BRUNAUX OLIVIER[4], RICHARD-HANSEN CÉCILE[5]
[1]ONCFS & Université de la Guyane, UMR EcoFoG, 97310, Kourou, France
[2]Cirad, UMR EcoFoG, 97310, Kourou, France
[3]INRA, UMR Amap & ONF (French Guiana)), 34398, Montpellier, France
[4]ONF R&D, 97300, Cayenne, France
[5]ONCFS, UMR EcoFoG, 97310, Kourou, France

Understanding the response of communities to spatially heterogeneous environmental conditions is an important challenge for ecologists. Whereas broad-scale Amazonian forest types have been shown to influence the structure of the communities of medium- to large-sized vertebrates, their natural heterogeneity within the terra firme rainforests remains poorly investigated. Here we question the drivers of the diversity and composition of medium and large fauna assemblages from a species-neutral, functional and phylogenetic perspective.
In this study, we disentangled the effects of various physical, biological and spatial covariates on the composition and diversity of 21 communities of 19 medium- and large-sized vertebrates in neotropical terra firme rainforests, French Guiana (~84,000 km²). We sampled each local vertebrates community using standardized line transects (sampling effort of ~5,000 km). We estimated species densities using distance sampling method taking into account temporary emigration and imperfect detection. Raw population density data were used to analyse species-neutral assemblages. Functional compositions and diversities were estimated from 9 morphological and behavioral traits while phylogenetic ones were measured from discrepancies between taxonomic levels (from species to classes). Physical environmental conditions were extracted from remote sensing data (e.g. mean landforms slope, mean elevation). Biological environmental conditions were estimated in the field (e.g. biomass, dominant tree families). Finally, geographic distances between sites were calculated to assess spatial effects on the structure of communities. We implemented variation partitioning to determine the relative importance of each covariate in shaping fauna assemblages.
At this spatial extent, we can hypothesize that biological conditions explain better composition and diversities than physical conditions because of their potentially direct influences on fauna. In addition, these results should allow us to better understand how much environmental filtering and geographical processes shape patterns of medium- and large-sized vertebrates distribution.

O52-11 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Large-scale Neotropical genera distributions predict drought-induced mortality of trees

ADRIANE ESQUIVEL MUELBERT[1], TIMOTHY BAKER[1], KYLE DEXTER[2], SIMON LEWIS[1], DAVID GALBRAITH[1]
HANS TER STEEGE[3], PATRICK MEIR[4], LUCY ROWLAND[2], GABRIELA LOPEZ-GONZALEZ[1], OLIVER PHILLIPS[1]
[1]University of Leeds, School of Geography, LS2 9JT, Leeds, United Kindom
[2]The University of Edinburgh, School of Geosciences, EH9 3FE, Edinburgh, United Kindom
[3]Naturalis Biodiversity Center, Biodiversity Dynamics from species to systems, 2333, Leiden, The Netherlands
[4]Australian National University, School of Biology, ACT 2601, Acton, Australia

Background: Droughts are an increasing threat for tropical rain forests, with impacts to forest biodiversity and ecosystem services, including carbon storage. Within the tropics tree species richness is positively associated with precipitation, which is likely to be a consequence of water-stress constraining important physiological processes of most taxa. If so, macroecological distributions of tropical taxa would provide valuable insights about the potential impacts of droughts on Neotropical diversity.
Methods: We combine data from 531 inventory plots of closed canopy forest across the Western Neotropics to investigate how water-deficit influences the distribution of tropical tree genera. For that, we firstly calculated genera 'water deficit affiliation' (WDA), which represents the mean of taxa distributions along the water-deficit gradient weighted by their abundance. Secondly, we tested the ability of WDA to predict drought-induced mortality at one natural and four experimental droughts across the Neotropics.
Results: Drought tolerant genera tend to be disproportionally widespread across the precipitation gradient, reaching even the wettest climates sampled. However, most genera are restricted to wet areas. Macroecological distributions did predict drought resistance, with wet-affiliated genera tending to show higher drought-induced mortality regardless of their life history stage and after accounting for the influence of phylogeny.
Discussion: The large-scale distributional patterns of genera with respect to climate have predictive value for their vulnerability to water-stress. It is the first time this question has been assessed at a macroecological scale for the tropics. Our results suggests that the anticipated increase in extreme dry events for this region may threaten biodiversity, given that the majority of Neotropical taxa are wet-affiliated and that most of these have relatively small ranges. Overall, this study establishes a baseline for exploring how floristic composition of tropical forests may shift in response to current and future environmental changes in this region.

O52-12 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Lianas reduce carbon accumulation and storage: results from a liana removal experiment

GEERTJE VAN DER HEIJDEN[1], JENNIFER S. POWERS[2], STEFAN SCHNITZER[3]
[1]University of Nottingham, School of Geography, NG7 2RD, Nottingham, United Kingdom
[2]University of Minnesota, Ecology, Evolution, and Behavior and Plant Biology, MN 55108, St. Paul, United States
[3]Marquette University, Biological Sciences, WI53201, Milwaukee, United States

Lianas (woody vines) are a key component of tropical forests. Lianas use trees for structural support to access the canopy, and competition between lianas and trees can substantially decrease tree growth and survival, leading to a reduction forest-wide carbon uptake. Lianas have recently been increasing in abundance and biomass in Neotropical forests, which may alter the carbon balance and cycle of tropical forests. Tropical forests store and sequester vast amounts of carbon and are contributing to approximately 40% of the global terrestrial carbon sink. The increase in liana abundance and biomass may reduce the capacity of tropical forests for carbon storage and sequestration and therefore impact the global carbon cycle. However, estimates of the impact of lianas on carbon dynamics of tropical forests are crucially lacking and it is therefore pertinent to investigate the effect of lianas on forest-level biomass dynamics. We established a large-scale liana removal experiment in the Barro Colorado Nature Monument in Panama. The aim was to simulate a forest that is essentially liana-free to assess the forest-level impacts of lianas on aboveground net primary productivity and the carbon balance compared with unmanipulated control plots in which lianas were present. Three years after liana removal, lianas reduced net above-ground carbon uptake by ~76% per year, mostly be reducing tree growth. Lianas additionally altered how above-ground carbon was stored. In forests where lianas were present, the partitioning of forest aboveground primary productivity was dominated by leaves at the expense of woody stems, resulting in a more rapid return of fixed carbon to the atmosphere. Additionally, preliminary results show that lianas have a relatively greater impact on net above-ground carbon uptake in the dry season compared to the wet season, lending support to the hypothesis that lianas may have a competitive advantage over trees in the dry season.
Our results demonstrate large differences in carbon cycling between forests with and without lianas. Combined with the recently reported increases in liana abundance, these results indicate that lianas are an important and increasing agent of change in the carbon dynamics of tropical forests and may be partially responsible for the long-term decline in the carbon sink function of Amazonian forests.

O52-13 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Impact of fire on resilience of tropical dry forests: miombo in Lubumbashi (Democratic Republic of Congo)

AURÉLIE HICK[1], MARTIN TOOTH[1], ALAIN TSHIBUNGU[2], GRÉGORY MAHY[1]
[1]University of Liège - Gembloux Agro-Bio Tech, Forest, Nature and Landscape Department, 5030, Gembloux, Belgium
[2]University of Lubumbashi, Faculty of agronomy, 7010, Lubumbashi, Democratic Replublic of Congo

Dry tropical forests are widespread in continental Africa where they account for 70-80% of forested area. Miombo is a dry forest characterized by the dominance of trees in the genera Brachystegia, Julbernardia and Isoberlinia. Dry-season fires are a characteristic feature of these forests. Fire is not a frequent natural disturbance but they originate from anthropic. The impact of fire on forest species depends on the intensity and timing in relation to plant phenology. Due to urban pressure, more than 85% of woodland forests were converted to savannahs given several degree of forest degradation in the landscape. After a disturbance, tropical forest ecosystem can return to a trajectory close to the original ecosystem. The time it takes for this ecosystem recover to its predisturbance ecological condition is termed resilience. Loss of resilience can trigger a shift to another ecological state with ecosystems that are different in species and/or that are different in their functional and structural aspects. The broad goal of our study was to examine impact of fire on resilience of miombo after human disturbances.
Mosaic of the MODIS 500m burned area product from 2002 to 2012 were used to calculate return frequency of fires around Lubumbashi. Five degrees of miombo degradation have been established: no degraded forest/little disturbed (level 1), moderately degraded forest (level 2), degraded forest (level 3), severely degraded forest (level 4) et deforested (level 5). For each degree of degradation, 9 circular plots (18 m radius, 0.1ha) were established, excepted for level 4 where 8 plots were laid. Within each circular plot, all woody individuals ≥ 2 cm diameter at breast height (DBH) were tagged, measured (height and diameter) and identified. Tree seedlings < 2 cm DBH and of height > 20cm were also sampled and identified. Herbaceous biomass was measured.
Floristic composition in level 4 corresponded to fire-tolerant species. In other degree of forest degradation, most abundant species in mature trees consisted to tolerant or semi-tolerant species. Floristic composition of regeneration in most degraded degree consisted to a mixte of miombo species and fire-tolerant species.
Fire has an impact on resilience of miombo after human degradation. Level 4 corresponded to a typical floristic community of a chipya habitat, where all woody species are fire tolerant. Fire can lead degraded miombo toward an alternative stable degraded states.

O52-14 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:00 – Sully3

Altered patterns of natural hybridization induced by anthropogenic land use? – Insights from a tarsier hybrid zone in Central Sulawesi

YVONNE E.-M. B. BOHR[1], AZHARI PURBATRAPSILA[3], JOKO PAMUNGKAS[3], STEFAN MERKER[2]
[1]Goethe University Frankfurt, Ecology, Evolution and Diversity, 60438, Frankfurt am Main, Germany
[2]State Museum of Natural History Stuttgart, Zoology, 70191, Stuttgart, Germany
[3]Bogor Agricultural University, Primate Research Center, 16151, Bogor, Indonesia

Habitat loss and degradation by land conversion affect multiple ecological processes of locally adapted species. Among these are tarsiers, small nocturnal rainforest primates from the Southeast Asian Archipelago. Throughout their range, tarsier populations are in decline due to conversion of their forest habitat into cropland. So far, however, little is known about how habitat disturbance affects evolutionary processes like speciation or introgressive hybridization, the stable incorporation of alleles from one species into the gene pool of another through repeated back-crossing. Here, we evaluate past and present patterns of introgression in two parapatric species of Central Sulawesi tarsiers, Tarsius lariang and T. dentatus. Both species maintain their respective integrity in spite of a shared hybrid zone detached from any geographic or ecological barrier. By vocal monitoring and analyses of a multilocus genetic dataset comprising maternally, paternally and bi-parentally inherited markers, we found evidence that between 2005 and 2012, the species boundary had moved in line with anthropogenic land use. Moreover, we observed differing patterns of introgression in both years: While our earlier survey revealed clearly asymmetric mitochondrial introgression from T. lariang into T. dentatus, our most recent study discovered at the very same site introgression in both directions. We hypothesize that this inconsistency in gene flow between tarsier populations reflects different stages of population dynamics induced by expanding forest conversion and facilitated by slightly imbalanced competitive abilities of tarsier species, eventually resulting in discrepant genetic patterns of hybridization and introgression.

O52-15 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Large lizards adapting to urbanization

ROBYN WILSON[1], LÉA BOUCHEREAU[2], GARY WILSON[2]
[1]Monash University Malaysia
[2]Sup'Biotech Institution Paris(3) Australian Tropical Herbarium, Cairns

Background: The Asian Water Monitor (AWM) Varanus salvator, average 2.6 m and 20 kg, and IUCN status Least Concern, occurs in waterways throughout Asia. However, there is limited data on their distribution and co-existence with humans. They are scavengers and also predators of bird and turtle eggs and hatchlings. AVM are harvested commercially in Asia for their skins and meat and taken opportunistically by locals for food and fat that is used for medicinal use. This study explored the occurrence of AWM in urban and peri-urban habitat and their response to the presence humans and other animals.
Method: We conducted three repeat 500 m transects that took 20-30 minutes, along channels, around lakes and parklands in peri-urban and urban areas in Peninsula Malaysia. We recorded the number of AWM along a transect, estimated their size, location to different habitat attributes (water, vegetation cover, shade), abiotic measurements (temperature and humidity), proximity to observer, response to human observer (flee, retreat slowly, freeze, watch the observer, submerge or swim away) and to other animals such as otters, long-tail macaques, and leaf monkeys.
Results: AWM were found in most channels on at least one site survey in both peri-urban and urban areas. They were also frequently sighted in parklands and in close proximity to or in tin lakes. Their primary response to humans was to flee when on land; in water they submerged when sighted at less than 5m and at greater distances from the observer they swam away. In contrast, when AWM were in close proximity to other animals they did not flee or retreat. Most AWM were lost from view in less than 5 minutes making focal animal studies difficult to conduct. There was no difference in reporting rates in peri-urban an urban survey locations.
Discussion and conclusion: Sightings of AWM in channels in peri-urban and urban areas suggest they are adapting well to urban environments. Their flight response in the presence of humans but not other animals suggests they are or have a history of negative interactions with humans. The wide distribution of AWM in Peninsula Malaysia especially in Greater Kuala Lumpur, with a human population of greater than 8 million (30% of the Malaysian total), show they have adapted to an urban environment. As successful scavengers they are well suited to the habitat provided by urban drains and channels in an Asian city environment.

O52-16 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Global oil palm expansion modeling and implications for environmental certification schemes

L. ROMAN CARRASCO[1], BEN PHALAN[2], DAVID P EDWARDS[3]
[1]National University of Singapore, Biological Sciences, 117543, Singapore, Singapore
[2]University of Cambridge, Department of Zoology, CB2 3EJ, Cambridge, UK
[3]University of Sheffield, Department of Animal and Plant Sciences, S10 2TN, Sheffield, UK

It is attractive to recommend the complete removal of forest from the oil palm food chain. However, the certification of palm oil as sustainable comes at a cost and if certification is to become more stringent, the costs are expected to grow.
We assess the impacts of increasingly stringent land-use regulation (or certification schemes) on the production costs of oil palm that meets future demands. We compare these costs to the area of forest land that would be spared and the bird biodiversity that could be saved, compared to an uncertified (business-as-usual) scenario. We do this by modeling the expansion of oil palm from Southeast Asia into Africa and Latin America using a spatial economics model combined with species area relationships for critically endangered and endangered tropical birds.
We find that future oil palm demand by 2020 could be easily met without further deforestation and minimal threat for endemic bird species by focusing conversion of grassland and pasture land mostly in Latin America (e.g. Los Llanos in Colombia and Venezuela). This scenario would increase production costs by $2.24 billion (equivalent to an increase of $0.034 in a Mars chocolate bar). Intensification of beef production or multi-crop oil palm–cattle landscapes could absorb the leakage generated by such a stringent oil palm certification scenario. Our results thus suggest that decoupling oil palm and deforestation might be an affordable strategy in the short term.

O52-17 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Beyond the growth-survival trade-off: Demographic dimensions of tropical trees

NADJA RÜGER[1,2], RICHARD CONDIT[2], DREW PURVES[3], BENJAMIN ROSENBAUM[1], CHRISTIAN WIRTH[1,4], S. JOSEPH WRIGHT[2]
[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany
[2]Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa Ancón, Panama
[3]Google DeepMind, 5 New Street Square, London EC4A 3TW, UK
[3]Universität Leipzig, AG Spezielle Botanik und Funktionelle Biodiversität, Johannisallee 21, 04103 Leipzig, Germany

The trade-off between sapling growth in high light vs survival in low light is a well-established axis of life-history variation in tropical tree species. However, growth and survival rates change during a trees' life as it grows taller and receives more light. We performed an integrated assessment of demographic rates of 290 tropical tree and shrub species on Barro Colorado Island, Panama, across tree sizes and light levels to derive essential dimensions of tropical tree demography.
We combined information on tree size and light availability by assigning each individual tree to one of four canopy layers based on the number of tree crowns above it. We used extensive inventory data and Bayesian methods to estimate growth and survival rates for each species in the four canopy layers as well as the number of recruits per unit of adult basal area. We performed a novel weighted Principal Component Analysis that allowed independently assigning weights to each demographic rate of each tree species to account for uncertainty associated with small sample sizes of rare species.
The most important demographic dimension was a general trade-off between growth and survival in all canopy layers corresponding to a fast-slow continuum of life-histories. Fast species were characterized by low wood density, tall stature and small seeds. The second dimension distinguished species with good (fast growth, high survival) vs bad (slow growth, low survival) performance in all canopy layers. The 'good' extreme of the continuum can be described as long-lived pioneer's syndrome and is associated with low regeneration rates and tall stature in line with the forest architecture hypothesis. The third axis differentiated species that performed well in the canopy vs species that performed well in the understory and is related to light-gradient partitioning. The three axes explained 41%, 20%, and 13% of overall variation in demographic variables, respectively.
Our results highlight the generality of the growth-survival trade-off across all tree sizes and levels of light availability. Differential performance in canopy vs understory is comparatively less important. Moreover, the long-lived pioneer syndrome may be more relevant to describing tropical tree life-histories than previously thought. This integrated analysis of tropical tree life-histories may serve as a basis for comparison with other forests differing in disturbance regime or phylogeographic history.

O52-18 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

Floristic dynamics in space and time in West Amazonian peatlands

FREDERICK DRAPER[1], KATHERINE ROUCOUX[2], EURIDICE HONORIO CORONADO[3], IAN LAWSON[2], TIM BAKER[1]
[1]University of Leeds, Geography, LS2 9JT, Leeds, UK
[2]University of St Andrews, Geography, KY16 9AL, St Andrews, UK
[3]Instituto de Investigaciones de la Amazonía Peruana IIAP, Probosques, 784, Iquitos, Peru

The extensive peatlands ecosystems of northern Peru are the most carbon dense ecosystems in Amazonia. However, despite their importance as a carbon stock, their floristic composition remains largely undescribed. Here we explore patterns of tree diversity and composition in two peatland ecosystem types – palm swamps and pole forests – using 27 forest census plots. We place our results in a regional context by making comparisons with three other major ecosystem types of western Amazonia, terra firme forests (27 plots), white sand forests (27 plots) and seasonally inundated forests (9 plots). We find that peatland ecosystems have extremely low (within-plot) alpha-diversity. In particular, pole forests have perhaps the lowest levels of diversity recorded in Amazonia. Despite substantial variation within both peatland ecosystem types (high beta-diversity), they are compositionally different from each other as well as from other ecosystem types in the region. Explaining these striking patterns of diversity has proved difficult when only present day processes are considered. However, by taking multidisciplinary approach incorporating palaeoecological data, we show that the most species-poor ecosystems are a relatively recent feature on the landscape. This finding suggests that ecosystem age may be a key determinant of their low diversity. These results demonstrate the importance of often-ignored historical processes in the assembly of tropical forest communities.

O52-19 – S52 *Free Session: Tropical ecology*
Thursday 23 June / 14:30-17:30 – Sully3

The Challenges and Opportunities of Conservation in Madagascar

PATRICIA C. WRIGHT[1, 2]
[1]Stony Brook University, Department of Anthropology, Stony Brook, NY, USA
[2]Centre ValBio, Ranomafana, Madagascar

Ninety percent of the natural forests of Madagascar no longer exist mainly because of fire. Ninety four percent of the lemur species are in an IUCN endangered category, and lemurs are the primary seed dispersers of the trees that compose the forest. Forests prevent erosion and landslides, filter the water for drinking, and provide reasons for tourists to infuse the country with tourist funding. Conservation programs began in Madagascar in the early nineties to save primarily the remaining rainforest and the wildlife within it. During the past 25 years, conservation progress has been slow. New threats have increased including mining of cobalt, nickel, titanium, sapphires and gold. Due to political unrest and enforcement leniency, illegal logging of precious hardwoods has opened up and devastated more pristine forests. Hunting of wildlife and selling of lemurs for cash increased. It became obvious to conservationists that the scope of the problem was too vast, and the financial resources too small to save forests using conventional methods. Experiments in community management of forests gave hope that local people might be major players in forest preservation. As funding becomes available for the slowing of climate change, addition of technology such as sensors, drones, camera traps and GIS make monitoring and mapping easier and possible tasks. New revenue streams such as reforestation, and planting forest cash crops such as vanilla, wild pepper, cinnamon, essential oils and chocolate may increase the economic incentives not to burn forests. The value of standing trees may be higher than rice farming. At Ranomafana National Park after thirty years of constant conservation efforts including health, education and vocational training for local people, we are optimistic that communities will join conservationists to both protect wildlife and the forests.

O53-Introduction – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

The Challenges and Opportunities of Conservation in Madagascar

PATRICIA C. WRIGHT[1,2]
[1]Stony Brook University, Department of Anthropology, Stony Brook, NY, USA
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O53-01 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Long-term monitoring for adaptive ecosystem management in south-western Madagascar

JOACHIM NOPPER, YEDIDYA RATOVONAMANA, JANA RIEMANN, JÖRG GANZHORN
Hamburg University, Animal Ecology and Conservation, 20146, Hamburg, Germany

Rapid loss of the remaining natural vegetation as well as the high degree of animal and plant endemism justifies the inclusion of the dry forests of south-western Madagascar into a global priority area of high conservation concern. The main drivers for degradation and deforestation are shifting cultivation and unsustainable charcoal productions. The local population greatly depends on natural forest products for subsistence purposes. The challenge is to establish management concepts that reconcile this high dependency with ecosystem protection. This is aggravated by the many stakeholders with differing interests that are involved in implementation and decision making in conservation management. They range from local individuals to communities to regional authorities up to national authorities and the international community.
The Mahafaly region in southwestern Madagascar is an example where a growing human population and a subsequent increase in demands of forest products and arable land will enormously increase the pressure on the remaining natural vegetation. Today, forests inside the Tsimanampesotse National Park but also some sacred and community forests outside the park boundaries are still excluded from land conversions. However, even with current deforestation rates the continued existence of these forests is highly threatened. To protect forests and associated biodiversity, integration of the anthropogenic landscape in conservation planning and information on the effects of different forms of land use on ecosystems is necessary. Long-term monitoring programs can provide this necessary information on changes to biodiversity that are associated with environmental alterations such as land use and climatic changes. Even though instruments of monitoring exist, tools to evaluate current impacts of land use on ecosystems have not yet been fully implemented. In particular, local communities are often left out of the conservation planning process, resulting in misunderstandings between the parties affected. Therefore, emphasis could be put on integrating local communities into monitoring programs that are run by the community or "eco-guards" and coordinated by an official conservation organization.

O53-02 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Dissecting change: Assessing farmers' perceptions and strategies in Madagascar

NATASHA STOUDMANN[1], PATRICK WAEBER[1], CLAUDE GARCIA[2]
[1]ETH Zurich, Environmental Sciences, 8092, Zurich, Switzerland
[2]CIRAD, Goods and Services of Tropical Forest Ecosystems, 34398, Montpellier, France

Throughout the tropics, change stemming from instabilities in for example the political, economic, social, climatic or environmental dimensions is increasingly being felt by rural people. Farmers are particularly vulnerable to these changes, with their livelihood often being solely dependent on agriculture. Madagascar's Maningory watershed encompasses the Alaotra and Analanjirofo regions, both of which are agricultural hubs of the country – the Alaotra largely for its rice production, Madagascar's staple food, and Analanjirofo for its cash crops (e.g., cloves and coffee). This study aims to gain a better understanding of how the main resource users of the watershed perceive and behave in the face of ongoing change. This is achieved by employing the Q methodology, used for the quantitative study of shared subjectivity, in order to investigate the viewpoints of the main resource users regarding 1) their understanding and perception of change 2) their proactive behaviour to identified change, and/ or 3) their reactive behaviour to perceived/encountered stresses and shocks ranging from decreasing quantity of rain to increasing schooling fees. Exploring the existing attitudes of main resources users regarding the broad subject of change allows for a better framing of what could potentially be done – from a policy, community or individual point of view – to improve their resilience capacity to present and future changes.

O53-03 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

The original interactions between actors in natural resources tenure rights in Antanandava, Madagascar: the household, the family and the State

PATRICK RANJATSON[1], BRUNO RAMAMONJISOA, HARIFIDY RAKOTO RATSIMBA[1], NATHALIE BODONIRINA, HOBY VOLATIANA RANJAHARIVELO, LUCIENNE WILMÉ[2], PATRICK WAEBER[3]
[1]Département des Eaux et Forêts de l'Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, BP 175, Antananarivo 101, Madagascar
[2] Missouri Botanical Garden, BP 3391, Antananarivo 101, Madagascar.
[3]Forest Management and Development, Department of Environmental Sciences, Swiss Federal Institute of Technology Zurich, 8092 Zurich, Switzerland

Although the complexity of the natural resources tenure rights is largely recognized in Madagascar, little has been reported from the field. This presentation is aimed at giving some empirically grounded analysis of the structure of natural resources tenure from the Antanandava case; and is based on the results obtained from two master studies within the AlaReLa Project. The tenure rights from the Antanandava Commune are described within the existing local rights governing the community. The preliminary results show the importance of the individual households, on one hand, and the family on the other. The larger community seems to have little influence on the natural resources rights, which points towards the importance to scrutinize the social interactions at larger community level. The natural resources tenure security cannot be achieved at the scale of families, unless there is a mechanism allowing negotiations and management of conflicts amongst families. This securing role is devoted to external structures, such as the Commune or the fokontany who intervene in conflict resolutions, and also in some land transactions such as land sales. When forest management is concerned, the preliminary results tend to show similar actors performing at different levels of governance. In other words, interactions are observed from individual households, or families, but not at another scale within the community, with the state services in charge of the forests, Madagascar National Parks, as the Park manager, as well as the Commune and the fokontany, but the community. When the formal associations created to manage the forest, the so-called COBAs or VOI, are considered, they seem to play an important role, but they cannot be regarded as a spontaneous and legitimate representation of the local community as a whole. Finally, our empirical data reveal, surprisingly, no clear pattern for the local social structure in charge of land tenure, it is not composed solely of individual households, nor larger entities from the community.

O53-04 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Observing changes at watershed scale: tracking spatial organization of land-use in the Alaotra Mangoro, Madagascar

HARIFIDY RAKOTO RATSIMBA[1], PIERROT RAMANAMANDIMBY[1], IHOBY H. RANDRIAMALALA[1], ANDO, J. RADONARISON[1], ANNICK RAVAKA[1], PATRICK RANJATSON[1], LUCIENNE WILMÉ[2], PATRICK WAEBER[3], BRUNO S. RAMAMONJISOA[1]
[1]Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, Département des Eaux et Forêts, 101, Antananarivo, Madagascar
[2]Missouri Botanical Garden, MBG, 101, Antananarivo, Madagascar
[3]Swiss Federal Institute of Technology, Forest Management and Development, Department of Environmental Sciences, 8092, Zurich, Switzerland

Madagascar is globally known for its biodiversity and high degree of endemism, but also for its continuous deforestation. The Alaotra Mangoro area is particularly known for the erosion gullys or lavaka across the landscapes, its vast fields of irrigated rice, surrounding the biggest lake of the Alaotra, with its marshes serving as habitat to Hapalemur alaotrensis, the only lemur constantly living on water. Out study is based on spatial quantitative data analysis between land use change and specific spatial parameters (distance to river and topography). Multispectral SPOT 5 satellites images from 2014 have been processed through pixel-based and object-oriented classification to derive land cover maps. The influence of topography on land cover distribution has been analyzed using statistical correlation estimates of slope derived from digital elevation model. The distance from river allows to have an explanatoryvariable which has been used to analyze landscape unit distribution. The results show that the forest cover area increase towards the periphery of the river (10.63% of dense forest and 11.63% of degraded forest in the study area). Lowlandswith less than 8% slopes were generally dominated by rice fields and other agricultural production. A large proportion of dense forests (72.17% of the total dense forest areas) are localized in medium slope (between 8% and 30%). The class of secondary successions follows this trend (54.61% in the same range of slope) which indicates forest degradation as alternative to the lack of arable areas in the lowlands (especially for slash and burns cultivation). The spatial repartition of the uses is progressive and is based on arable land needs and proximity (the river is the easiest way for village access where road and paths are missing). In this way, specific agriculture improvement has to be set up in order to capitalize the potential of current used land through local intensification (improving yields) but also through diversification and insertion of new high-income crops, especially in remoter areas. Spatial information on land use and change serves decision-makers as an efficient tool to make informed decisions to better balance agricultural needs with biodiversity values.

O53-05 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Marshland management in the Alaotra region (Madagascar) – Discussing preferences with local stakeholders on the basis of a role-playing game

CYRILL ZOSSO[1], PATRICK O. WAEBER[1], CLAUDE A. GARCIA[1], LUIS GARCÌA-BARRIOS[2]
[1]Swiss Federal Institute of Technology, Environmental Sciences, 8092, Zurich, Switzerland
[2]El Colegio de la Frontera Sur, Departamento de Agricultura, Sociedad y Ambiente, 24500, Campeche, Mexico

The Alaotra region represents an area of high agro-economic importance for rice and inland-fish production in Madagascar. However, the growing local population is confronted with declining productivity and reduced fish catches. The challenge on management and governance is how to best balance agricultural needs with biodiversity conservation values (e.g., Hapalemur alaotrensis). In order to allow for a meaningful and widely accepted management strategy, we need to understand preferences and attitudes of the main stakeholders, the rural fisher and farmers. Is it possible to envision shared understandings among them and with the policy makers?
Sierra Springs (developed by García-Barrios and colleagues), a serious role-playing game platform designed to assess coordination strategies in land-use challenges was used in a modified form. The rules and specific land uses were adapted to stylize the Alaotra wetlands in order to discuss questions of management and zonation preferences in this territory. In a series of 14 workshops, three scenarios with different management aspects were played.
In the first scenario of the game, low restrictions allowed people to freely zonify land uses in the wetland in their own terms, and to explain and justify some of their actions in the game. The second and third scenarios were designed to stimulate a discussion on the spatial distribution of conservation zones (i.e. with low intensity use). The results from the game sessions and the questionnaire put forward that many participants see the best solution in having well defined areas for conservation, distributed among the villages. Some arguments for this preference are local responsibility, easier surveillance and the fear of interference of neighboring villagers.
With some further adaptions to the rules, the game could further stimulate discussions on zoning distribution. It can help to assess the preferences between small, distributed conservation zones vs. rather large, central zones. In the Alaotra case it seems that the strategy of the local government to have the conservation zones distributed and managed by local associations in the villages is rather well aligned with some preferences assessed during the workshops.

O53-06 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Rice or lemurs, or rice and lemurs? A case study from the wetlands of the Alaotra, Madagascar

WILMÉ LUCIENNE
Missouri Botanical Garden Madagascar, Conservation and Research, BP 107, 101, Antananarivo, Madagascar

Increased demand for agricultural products, wood and fibers, and water, the aspirations of rural communities and a growing recognition of planetary boundaries outline the complex trade-offs resource users are facing on a daily base. Management problems typically involve multiple stakeholders with diverse and often conflicting worldviews, needs and agendas, in an environment with growing uncertainty. Such "wicked" problems have no common definition of what the problem is, nor do they have clear stopping rules. And research suggests people make decisions based on an illusion of understanding of the complexities of the systems they are involved in. How is it possible then to shatter this illusion? How to improve the flow of information between decision makers? What future landscapes will best resolve the apparently conflicting demands of the many stakeholders involved? We explore these questions through participatory modeling (Companion Modeling) and ethnopohotography of science, a term we have coined to describe our use of photography to explore the perceptions of the landscape by the resource users. We apply these methods in the socio-ecological landscape of the Alaotra, Madagascar. In the Alaotra, local farmers derive their livelihood from the production of rice, vegetables, wood and charcoal. The area of production – rice fields, eucalyptus and acacia plantations – is expanding over the remaining wetlands and forests, the benefits in production coming at the cost of biodiversity. Here, we have developed conceptual models that link actors, resources, norms and institutions, ecological processes and social dynamics through participatory modeling workshops. These involved farmers, academics, conservationists and decision makers. These workshops were held to identify drivers of and barriers to change and to explore alternative scenarios of landscape management. Recognizing and understanding the multiple linkages and feedback loops between all these components and processes is a crucial first step in the design of socially acceptable strategies. We propose improved resilience can only be achieved if the main resource users, in this case, the rural poor, see their needs reflected in the framework used to make decisions and if policy makers are able to shatter their illusion of understanding and recognize the complexity of the system they are managing. Ownership of conceptual models such as the ones we built then becomes critical for landscape governance.

O53-07 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Cultural values of Ficus in agrarian territories for the Betsileo (Madagascar) and their impacts on biodiversity conservation

VEROHANITRA M. RAFIDISON[1], VONJISON RAKOTOARIMANANA[1], BAKOLIMALALA RAKOUTH[1], YILDIZ THOMAS[2],
STÉPHANIE CARRIERE[3]
[1]University of Antananarivo, Department of biology and plant ecology, 101, Antananarivo, Madagascar
[2]CEFE, UMR 5175, 34293, Montpellier Cedex 5, France
[3]IRD, UMR GRED, 34394, Montpellier Cedex 5, France

Ficus species are important both in terms of socio-cultural role as well as keystone species in ecological networks. Ficus species found in different wooded areas and agricultural lands adjacent to a forest corridor between two national parks (Ranomafana and Andringitra) were studied. The interaction between the socio-cultural practices of the Betsileo ethnic group and the characteristics of the regenerating vegetation under these Ficus by nucleation were analyzed, to understand the place and role of these trees for the Betsileo ethnic group and identify the consequences of human practices on the biodiversity conservation in the landscape. The results revealed that: Ficus tiliifolia plays an important socio-economic role, F. reflexa and Ficus lutea presents symbolic protective role for men and animals. This latter is a marker of social space and is believed to be associated with different powers. The analysis of the regenerating vegetation by nucleation shows that isolated Ficus displays the key role in the processes of forest regeneration: forest species richness is higher compared to the one found in fallows without Ficus. This analysis combining human science and biology, allowed us to high light the impact of social practices on conservation processes. In the case of Ficus, the social practices promote the conservation of plant biodiversity in transitional zones between forest and agrarian territories, which is particularly sensitive to the conservation of biology.

O53-08 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Effective Integration of Human Healthcare and Ecosystem Conservation for the Greater Ranomafana Ecosystem, Madagascar

THOMAS GILLESPIE[1], BENJAMIN ANDRIAMIHAJA[2], MATTHEW BONDS[3], PATRICIA WRIGHT[4]
[1]Emory University, Environmental Sciences & Environmental Health, 30322, Atlanta, USA
[2]MICET, Centre Valbio & Pivot, Antananarivo, Madagascar
[3]Harvard Medical School, 02115, Boston, USA
[4]Stony Brook University, Anthropology, 11794, Stony Brook, USA

Since 2003, Centre ValBio (CVB) has worked to protect Madagascar's unique and biologically diverse ecosystems through conservation science and efforts that directly benefit the local people, including a rural healthcare delivery program that integrates human and environmental health at the community level. This healthcare program is complemented by conservation education and reforestation programs that highlight the unique biodiversity of Madagascar while simultaneously improving nutritional conditions for villagers and the sustainability of community approaches to natural resource use. Recently, with the help of Partners in Health, CVB has incubated Pivot to provide comprehensive health system strengthening for the region around Ranomafana National Park. This collaboration greatly enhances CVB's ability to work in partnership with communities in resource-poor areas to protect biodiversity and break cycles of poverty and disease. We will provide an overview of this effort and highlight opportunities and challenges of this approach that may be generalizable to other sites where biodiversity conservation and community-based healthcare may align.

O53-09 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Selective slashing coupled with compost amendment can lead to a sustainable slash and burn agricultural system in Madagascar

JUSTINE GAY-DES-COMBES[1], ROBERT MILLS[2], BJORN ROBROEK[1], DOMINIQUE HERVÉ[3], BRUNO RAMAMONJISOA[4], JEAN-CHRYSOSTÔME RANDRIAMBOAVONJY[4], SAMUEL RAZANAKA[5], ALEXANDRE BUTTLER[1]
[1]EPFL, ENAC, 1015, Lausanne, Switzerland
[2]Lancaster University, Lancaster Environment Center, LA1 4YW, Lancaster, UK
[3]IRD, UMR GRED, 34394, Montpellier, France
[4]Ecole Supérieure des Sciences Agronomiques, Eaux et Forêts, 101, Antananarivo, Madagascar
[5]Centre National de Recherche pour l'Environnement, Agronomie, 101, Antananarivo, Madagascar

Forests of Madagascar are home to a rich and unique biodiversity. However, biodiversity is diminishing every year, partly because of slash-and-burn agriculture. On the west coast, corn is the main crop cultivated with this technique. It is observed that corn field yield decreases dramatically after 4 years of cultivation, forcing farmers to abandon their fields and burn new patches in the primary forest. We tested a selective slashing coupled with compost amendment on degraded forest soils in secondary forests to enhance and sustain production, with the final goal of reducing human pressure on the primary forest. This compost was made with local trees which were abundant in the secondary forest and not commonly used by villagers.

Three sites were selected in the forest of Kirindy, in the Menabe region. We removed all the vegetation on half of the surface of these sites, and only shrubs and some trees on the other half to reach a canopy cover of ca 50%. On each of these surfaces, four soil treatments were applied: control, ashes, compost, and compost + ashes, which lead to a split plot design. On each plot, we grew 10 corn plants. Both corn plants development and soil were monitored and sampled during the months of the growing season 2015 up to final harvest.

Results show a dramatic effect of the combination of compost with ashes on the corn yield which was multiplied by 3 to 4 in comparison to ashes or compost alone. Plants had also a higher survival rate and developed faster. On control plots, yield was negligible, showing the poor soil fertility. In contrast, soil chemical parameters related to fertility and microbiological activity increased in the compost + ashes mixture. Ashes increased pH, which in turn promoted microbial activity and thus the mineralisation of added organic matter. Furthermore, the presence of the tree canopy contributed to maintain a favourable soil moisture and enhanced soil microbial activity.

While slash-and-burn practices are usually dismissed because of their destructive impact, our study points to some derivative methods of slash-and-burn practices which would allow a more sustainable use of secondary forests and still meet a high social relevance. Our results were show-cased to local villagers and rapidly adopted by some of them.

O53-10 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

If soil fertility is not the problem, compost is not the solution

CÉLINE DILLMANN[1], SWEN BOS[1], JUSTINE GAY-DES-COMBES[2], ALEXANDRE BUTTLER[2], CLAUDE GARCIA[3]
[1]Swiss Federal Insitute of Technology, Forest Management and Development (FORDEV) Group, Department of Environmental System Sciences, 8092, Zurich, Switzerland
[2]Swiss Federal Insitute of Technology, Laboratoire des Systèmes écologiques (ECOS), 1015, Lausanne, Switzerland
[3]Centre International de Recherche Agronomique pour le Développement (CIRAD), Tropical forests goods and ecosystem services, 34398, Montpellier, France

The landscape of Central Menabe in West Madagascar is characterised by dry deciduous forest, but deforestation puts pressure on this ecosystem. Subsistence slash-and-burn agriculture is considered to be one of the main drivers of deforestation. Its impact on the local ecosystem and livelihoods highlights the need for alternative and hopefully more sustainable cultivation. Research has proven that the inclusion of local knowledge in the design of an intervention seeking to bring about changes in farmers' practices is useful. It reveals factors influencing farmers' decisions that might have been otherwise overlooked by academics, yet might be crucial for changing the local stakeholders' management practices.
This study is embedded in a larger project seeking to introduce a compost, made from local trees and combined with ashes in slash-and-burn cultivation, that would help maintaining soil fertility and therefore reducing the need for new land from the forest by the farmers. On the side of the soil analysis and field trials, we conducted a survey of the farmers' local ecological knowledge on soil fertility and other soil properties relevant to yield.
This study relies on a set of repeated interviews with farmers from a village in the study area. The collected knowledge was recorded in a knowledge base according to the formal grammar of the 'Agro-ecological knowledge toolkit' software.
Based on the information gathered, we provide an insight into the nature of farmers' knowledge and their perception of the ecological system they live in. This analysis allowed the identification of determining factors that drive their decisions. In spite of the importance of soil fertility, weed management appeared to be the more relevant factor urging farmers to shift their fields and clear new forest patches. As long as the dominating problem of weed management is not addressed, farmers will probably not adopt the compost as a novel technique to ensure longer cultivation periods on the same field.
Based on our findings, we argue that future research needs to widen its scope in order to integrate the needs, constraints and aspirations of the local actors, if changes in natural resource management are to be adopted in practice. The elicitation of local knowledge is a good place to begin.

O53-11 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Understanding change and stakeholders engagement to improve natural resources management, a case study from Madagascar

BRUNO RAMAMONJISOA[1], HARIFIDY RAKOTO RATSIMBA[1], ANNICK RAVAKA[1], PATRICK RANJATSON[1], LUCIENNE WILMÉ[2], PATRICK WAEBER[3]
[1]School of Agronomy, University of Antananarivo, Forest and Water Department, 101, Antananarivo, Madagascar
[2]Missouri Botanical Garden, Madagascar Research & Conservation program, 101, Antananarivo, Madagascar
[3]Swiss Federal Institute of Technology Zurich, Forest Management and Development, Department of Environmental Sciences, 8092, Zurich, Switzerland

A growing challenge in tropical terrestrial resource management is the reconciliation of a continuously increasing demand for agricultural products while balancing a growing number of values and interests such as environmental values for biodiversity conservation, maintaining ecological functions and providing critical ecosystem services for supporting rural livelihoods. The socio-ecological landscape of the Alaotra-Mangoro in Madagascar has been assessed through an institutional analysis integrating all stakeholders (from resource users up to the decision-makers) to document and understand change behavior based on logical process of decision, economic (e.g., price of agricultural products, non-timber and timber forest products) and ecological changes (e.g., deforestation and fertility loss). The quantitative and qualitative analyses have been complemented with a Role Playing Game to understand the weight of each actor in the arena. Results show that the interest of stakeholders is not only based on economic factor (price), but also, on the social interaction of all stakeholders with intrinsic power relationships that have emerged inside the arena itself. While a socio-economic system undergoes changes, the stakeholder's arena show characteristics of a self-organizing systems (e.g., connectedness, growing network of interactions, symmetry breaking, adaptation). In this sense, the possible alternative of natural resources management has to be created by the stakeholders themselves but has to be based on a better understanding of the entire socio-ecological system and build capacity in order to improve resilience thinking and policy making processes.

O53-12 – S53 *Tipping points in Madagascar's anthroposphere: integrating human needs with ecosystem conservation*
Thursday 23 June / 08:00-12:00 – Pasteur

Strengthen marine biodiversity conservation through community-based approach in Ambodivahibe protected area

ANDRIAMARO LUCIANO[1], YACINTHE RAZAFIMANDIMBY[1], JOMAZANDRY[1], ANDRIAMBOLANTSOA RASOLOHERY[1], VOLANIRINA RAMAHERY[2]
[1]Conservation International, Science and Knowledge, 101, Antananarivo, Madagascar
[2]World Wide Fund, Marine Program, 101, Antananarivo, Madagascar

Ambodivahibe marine protected area (MPA), definitely settled with decree in April 2015, is located in the northernmost region of Madagascar, with 36,976 ha. It is exceptional for its coverage of healthy coral reefs and abundance of large individuals of endangered species. It occupies the marine and coastal area and is characterized by the presence of islands, narrow rocky coastline interspersed with beaches, coral reefs, mangroves, and dense dry forests called Ampio, the only remaining fragments of coastal forest in northern Madagascar.

Before the temporary protection in 2010, Ambodivahibe followed the standard formal steps of protected area creation by referring IUCN principles. From the beginning of the process in 2007, local communities are taking important roles to define protection and sustainable use zones through LMMA approach. Patrols by communities take place approximately four times per month and group 10 rangers if they use motorized boat, and 6 rangers if they use pirogue (women included). A committee composed of the fishing service, local association of fishermen and the military conduct periodic monitoring and enforcement of the reserves. During the actions, data are collected on date, time and site are recorded. During the establishment of the management plan of the Ambodivahibe site, improvement has added to include the results of vulnerability analysis on climate change.

Started with 13,400 ha marine area, the Ambodivahibe MPA is currently about 39,794 ha in order to take in account the large fishing zones for the sustainable use for local communities. Currently, Ambodivahibe MPA has more than 14 marine reserves in the 4 villages which are 8 permanent reserves and 6 temporary reserves. While the exponential growth in fish catch that has followed, the communities from four villages have become more motivated to monitor their marine ecosystems. The catch of octopus has responded particularly rapidly, from 600kg in 2010, to 5 tons in 2015 and the biggest octopus caught by fishermen reached 8kg and one fisherman can collect a maximum of 40 kg.

The IUCN category V to manage Ambodivahibe MPA shows this essential of interaction between people and nature that create the sustainability of the area and its associated resources with its values. Though most local people are beginning to hold the importance of using no-take zones to preserve fisheries, support and close monitoring are still needed before communities can fully manage it on their own.

O54-01 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Justification for an energy-food-water nexus approach in charcoal production systems: Introduction to the Symposium topic

BAILIS ROB[1], MWAMPAMBA TUYENI[2], GHILARDI ADRIAN[3]
[1]Stockholm Environment Institute, US Center, 02144, Somerville, USA
[2]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, México
[3]Universidad Nacional Autónoma de México, Centro de Investigaciones en Geografía Ambiental, 58190, Morelia, México

Charcoal is a little understood biomass-based energy that is used by 60 to 90% of urban and peri-urban households in Sub-Saharan Africa, by millions of food vendors in the cities and towns of tropical nations, and in the restaurant and backyard grills of developed and developing countries alike. In the tropics, where demand has been increasing parallel with urbanization and population growth, charcoal tends to be produced from natural forests, raising concerns about the sustainability of production and resulting in policy measures including attempts to limit or ban production and promote alternative fuels via tax breaks, subsidies and other measures. However, we question whether charcoal is as problematic as it is often portrayed and suggest that policy measures designed to promote sustainable production may be preferable to policies that attempt to limit it. Indeed,charcoal production occurs in complex landscapes that host multiple landuse activities. It is extremely difficult to decipher the effects of charcoal from those of crop or livestock production. More appropriate policies require understanding the charcoal production landscape and the multiple social and ecological factors that determine what is (or could be) produced, how much, and by whom.
In this opening presentation, we will introduce the general patterns of defining charcoal with respect to the types of biomes & vegetation types where production occurs, and the types of land uses that are co-located with charcoal production. An widespread preference for dense charcoal results in production that is focused in tropical dry forests and shrublands where small hardwood species are found. Subsistence crop and/or livestock production are common, but rainfall is highly seasonal and water is often scarce. The individual and combined effects of energy and food production on the underlying hydrology and other ecosystem services is not well characterized, but understanding these interactions would be critical in order to assess the long-term sustainability of the system as a whole.

O54-02 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Barriers to legally compliant charcoal production by large landowners in Kenya

OWEN MATTHEW
Kikenni Consulting Ltd., Biomass energy consulting, BS26 2BA, Axbridge, United Kingdom

Woodfuels account for nearly 70% of primary energy consumption in Kenya. Demand has never been higher and prices are at record levels. While this represents a significant commercial opportunity for private landowners, none have been authorised to produce charcoal under the 2009 regulations. As supply from community land is increasingly constrained, a greater understanding is needed of charcoal supply from private land.
A study was undertaken in 2013 of large landowners producing charcoal, documenting their experiences and identifying barriers to regulatory compliance. It was found that:
- Large landowners produce charcoal as a by-product of a more lucrative core business, such as cattle ranching or commercial forestry. They do not set aside land for charcoal production and are not, by profession, charcoal-makers.
- Landowners apply various models of cost-sharing in charcoal production, from fully internalised operations to out-sourced systems run by itinerant groups.
- Management models and technology choice are a balance of cost, efficiency, speed and labour, and are specific to each context.
Landowners' compliance with the 2009 regulations is impeded by lack of awareness, lack of clarity and consistency in what is expected; prescriptive rules that may not be deemed appropriate; absence of delegated authority within the Kenya Forest Service; and fear of attracting attention. Taken together, this amounts to disproportionate costs of compliance when charcoal is not a core business.
Deregulation, decentralisation and elimination of movement permits are recommended, to facilitate compliance, encourage investment and bring the charcoal industry into the modern, formal economy.

O54-03 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

At the wooden cross-road: Transforming the vicious cycle of unsustainable charcoal production into a virtuous cycle of increased producer's resilience in Sub-Saharan Africa

KLAS SANDER[1], HARRY HOFFMANN[2], MICHAEL BRÜNTRUP[3]
[1]World Bank, GP Environment & Natural Resources, 20433, Washington DC, USA
[2]ZALF, Institute of Socioeconomics, 15374, Müncheberg, Germany
[3]Deusches Institut für Entwicklungspolitik / German Development Institute (DIE/GDI), Nachhaltige Wirtschafts- und Sozialentwicklung, 53113, Bonn, Germany

In Sub-Saharan Africa, more than 90% of the population depends on woodfuels to meet basic energy needs. The associated value chain provides livelihood opportunities for millions of people, especially in rural areas. However, the unregulated nature of these value chains jeopardizes all dimensions of sustainability– economic, social, and environmental. This affects vulnerability of the vast number of small-scale producers in several ways: the degradation of natural resources poses a threat to food, water, and energy security; the operation in a de jure illegal environment exposes actors to continuous threat by corrupt government officials; and the allocation of economic benefits towards powerful networks controlling marketing routes limits marginalized households in capturing the true economic benefits of these value chains. Consequently, the governance situation of charcoal value chains in SSA is reaching a critical crossroad: A continuation with the status-quo will inevitably lead into aggravating a vicious cycle of unsustainable management of natural resources, people, and the rural economy. In response to this challenge, a multi-level policy approach is proposed to carefully design and manage a virtuous cycle of sustainable charcoal production that increases food and energy security, reduces social vulnerabilities, and enhances the economic resilience of producers. Incentives structures have to be created that take account of the needs and decision making of rural households. Costs and benefits are valued by the rural population at the prices they face and they decide how to use their land in light of their own objectives. Even where off-farm effects are the main concern, providing the right incentives at farm level is fundamental. Then, trees can be perceived as highly flexible "cash crops" that have the potential to serve as "hidden reserve" liquidated for income generation in times of shortages. This paper argues that an essential requirement to successfully address the water-energy-food nexus lies in a well-balanced and carefully implemented formalization of charcoal production, including property rights, legalization of trade, and improved economic participation of all actors. Preliminary results of show that rather than focusing on short-term interventions targeting the broad framework of unsustainable wood energy value chains leverages significant development benefits. Policy recommendations are discussed and future research needs highlighted.

O54-04 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Tackling complexity in a changing climate: the role of charcoal in relation to energy transitions and agricultural transformations in low income countries

LOUISE KARLBERG, AARON ATTERIDGE, OLIVER JOHNSON
Stockholm Environment Institute, n.a., 10451, Stockholm, Sweden

Sustainable energy transitions are often described in terms of shifting away from traditional biomass use including fuel wood and charcoal, towards options like more efficient bioenergy or grid-connected electricity generated by hydropower. While alternative energy may reduce environmental degradation at the local scale, its effect on other components of the socio-ecological system can be far-reaching and profound. For example, the practice of burning charcoal to provide household cooking and heating needs, common in many parts of sub-Saharan Africa, creates an array of concurrent health, livelihood and environmental dynamics. It follows then that any change in household energy practices, such as a shift away from charcoal use, implies an impact not only on the physical environment (where benefits might be expected) but also across the social and economic contexts in which charcoal economies exist. The production, transport and sale of charcoal, along with the fabrication of small household stoves by tinsmiths, provides a range of livelihood opportunities for an array of different actors – including many who are among the poorest. Based on previous experience from studies on the energy-food-water nexus conduced in sub-Saharan Africa, we propose a systems approach that can facilitate exploration of these complex interactions in charcoal production systems through multi-stakeholder dialogue. Doing so makes explicit the physical resource trade-offs and the social and economic inter-linkages between competing interests and agendas, and provides the platform to begin the process of addressing this complexity in meaningful ways to support planning and policy-making processes, and to guide financial and technological interventions.

O54-05 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Social-ecological systems contexts underlying the sustainability of charcoal value chains along the energy-water-food nexus in African landscapes

MIYUKI IIYAMA[1], HENRY NEUFELDT[2], MARY NJENGA[3], PHIL DOBIE[4], RAMNI JAMNADASS[5], JEREMIAS MOWO[3]
[1]Japan International Research Center for Agricultural Sciences (JIRCAS), Research Strategy Office, 305-8686, Tsukuba, Japan
[2]World Agroforestry Centre (ICRAF), Science Domain 6 Climate Change, 30677-00100, Gigiri, Kenya
[3]World Agroforestry Centre (ICRAF), Eastern and Southern Africa Region, 30677-00100, Gigiri, Kenya
[4]World Agroforestry Centre (ICRAF), Senior Fellow, 30677-00100, Gigiri, Kenya
[5]World Agroforestry Centre (ICRAF), Science Domain 3 Tree diversity, domestication and delivery, 30677-00100, Gigiri, Kenya

Background: The production and use of charcoal is an important socio-economic activity in sub-Saharan Africa (SSA). Currently charcoal production and use often result in serious tradeoffs between socio-economic and environmental outcomes. These include meeting urban energy demands and supporting livelihoods of people across the value chain, which depending on the intensity of harvest, either shape or degrade productive multifunctional landscapes essential for food and water security, and ecological resilience. While charcoal demand is expected to grow in coming decades, limited understanding of socio-ecological contextual mechanisms to determine economic and environmental trade-offs at the landscape scale deters properly guided policy interventions. This paper presents a new insight to understand the contextual mechanisms underlying the (un)sustainability of charcoal production and use within the wider socio-ecological contexts of SSA landscapes.
Method: We propose a systematic approach to characterize the charcoal sector in SSA from the landscape perspective to examine synergies or tradeoffs between socio-economic and environmental outcomes. We apply the approach to the analysis of data from Kenya, Ethiopia and Rwanda where energy-water-food nexus issues vary depending on socio-ecological contexts.
Result: The approach reveal varied energy-water-food nexus outcomes depending on socio-ecological contexts: charcoal production as a part of land clearance in watersheds with significant biodiversity values in Mara, Kenya; charcoal production as a part of farmers subsistence livelihoods and land management in an agricultural landscape in Central Ethiopia; and intensive woodlot management for charcoal production as a part of agricultural intensification in a densely populated agricultural landscape in western Rwanda.
Discussion: Not only climatic, ecological and demographic factors, but also institutional, market, policy and preference contexts lead to varied outcomes on food, water security and ecological resilience. We recommend that future charcoal intervention should consider socio-ecological contexts and how to balance social and ecological outcomes to transform the charcoal sector for healthy landscapes.

O54-06 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Soil hydrological and physical properties in charcoal production landscapes

ALBERTO GOMEZ-TAGLE
UMSNH, INIRENA, 58330, Morelia, Mexico

Charcoal production is widespread in several regions in central Mexico and is a major driver of land cover change. We studied the effects of charcoal production on several soil physical, including hydrological, properties in oak and pine-oak charcoal production forests in Cuitzeo basin in central Mexico. Surface soil field infiltration measurements were performed in situ with automated tension infiltrometers and saturated hydraulic conductivity (Ksat) was estimated from steady state infiltration flux measurements. We collected core and composite samples from 10 randomly selected sites at 0-5 and 5-10 cm layers at charcoal-site and control adjacent field soils. Samples were used to determine bulk density, total porosity, soil texture, color and organic carbon content. We contrasted Ksat rates with individual storm intensities occurring in the study area.
The results show that Ksat under charcoal kilns increased significantly. Bulk density on charcoal sites was reduced compared to control sites and total porosity increased. As expected soil color was darker under charcoal kilns at 0-5 cm but darkness decreased at 5-10 cm. Higher infiltration flux rates were measured on charcoal-site soils and <5% storms exceeded charcoal-soil Ksat thus being able to produce overland flow.

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Thursday 23 June / 14:30-17:00 – Pasteur

A long-term socioecosystem research approach to understand water dynamics in a tropical dry deciduous forest of México´s Western Coast

MAASS MANUEL1, BALVANERA PATRICIA1
Universidad Nacional Autonoma de Mexico (UNAM), Instituto de Investigaciones en Ecosistemas y Sustentabilidad (IIES), 58190, Morelia, Mexico

Water participates in most energy fluxes and nutrient cycling processes within ecosystems. This important integration character of water makes its dynamics a key aspect determining ecosystem structure and functioning and a major limiting factor for ecosystem productivity, including food and biomass production. Tropical dry deciduous forests are particularly useful in studying these water-food-energy interactions since these ecosystems have a strong seasonal character, in which 80% of the yearly rain falls in juts 4 months, creating a strong dry-wet dynamic.
Human needs of energy, food and water induces natural ecosystems transformations, damaging its integrity and seriously disrupting its water dynamics; in turn compromising its ecosystem capacity to supply essential goods and services to society. Human technological capabilities to transform nature no longer allows seeing us just as another species in the ecosystem. The socioecosystem concept is an attempt to recognize the human-bio-physical nature of our world in a more integrated and interconnected way.
Dealing with these highly complex adaptive systems requires new epistemic approaches and research methods. The long-term, site-based, bottom-up and trans-disciplinary approach is the response of some Long Term Ecological Research (LTER) groups to deal with this endeavor. At the International LTER (ILTER) network, we have developed a conceptual model linking ecosystem integrity, ecosystem services and stakeholder well-being as a way to analyze trade-offs among ecosystem services inherent in management options.
At Chamela Mex-LTER site, for the last 30 years, we have been studying the ecosystem ecology of the tropical dry deciduous forest in the Mexican pacific coast. On the last 10 years a more socio-ecological approach has been conducted and, currently, a trans-disciplinary approach is in its process of been established. Recently (last October 2015) the study site was on the path of hurricane Patricia, seriously disrupting forest structure and functioning. This represents a unique opportunity to study the socioecosystem response to this intense hydro-meteorological phenomenon, linking water-food-energy components within a nexus approach.

O54-08 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
Thursday 23 June / 14:30-17:00 – Pasteur

Integrated assessment of the nexus between charcoal, food, and water using MuSIASEM

MARIO GIAMPIETRO[1, 2], RAFAEL GONZÁLEZ-LÓPEZ[2]
[1]Institució Catalana de Recerca i Estudis Avançats (ICREA), 08010, Barcelona, Spain
[2]Universitat Autònoma de Barcelona (UAB), Institut de Ciència i Tecnologia Ambientals (ICTA), 08193, Bellaterra, Spain

We present a 'meta-grammar' based on the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) approach to study the nexus between energy, food and water in tropical systems that integrate agriculture (crops and livestock) with charcoal production, and where charcoal is a key source of household income and cooking energy. The meta-grammar builds on Georgescu-Roegen's flow-fund model: It defines what the farming system is in terms of fund elements (human activity, managed land) and what it does in terms of flow elements (charcoal, food, water, and monetary flows). The viability and desirability of the metabolic pattern of the farming system is assessed by flow rates per hour of human activity, based on a choice of socio-economic categories that reflect the integrated set of activities required to reproduce the farming system. These flow rates are then related to desired/expected levels of labor productivity, consumption, and wages. Information on the feasibility of the metabolic pattern (referring to the ecological side – boundary conditions or external constraints) is derived from flow densities per hectare of land-use. The analysis of external constraints on both the supply side (limits to the productivity of the system) and on the sink side (potential damage to the embedding environment) makes use of Geographic Information Systems and allows us to scale the impact of the metabolic pattern of the farming system across different types of ecological funds (terrestrial ecosystems, aquatic ecosystems, aquifers, soil, atmosphere).
We illustrate the application of the meta-grammar to tropical farming systems with benchmarks derived from the literature, and show (i) how to keep coherence in the organization of data required for the integrated assessment of the water-energy-food nexus, (ii) the existence of forced internal relations among the metabolic characteristics of the farming system (the Sudoku effect). The Sudoku effect implies that human activity (labor) and land used for food production cannot be used for charcoal making, and so on. At the same time, the internal combination of production factors (human activity, land, energy, water) must express a metabolic pattern that is compatible with the boundary conditions (external constraints), that is, the availability of land, water and energy resources, and environmental services.

O55-01 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

Space for Hunting: Understanding Indigenous and other Hunters' Impacts in the Congo Basin Forests

JOHN FA, JESUS OLIVERO, ANDREW NOSS, HIROKAZU YASUOKA, MICHAEL RIDDELL, JEROME LEWIS, SERGE BAHUCHET, MIGUEL ANGEL FARFÁN, JESUS DUARTE, ROMAIN DUDA, SANDRINE GALLOIS, GUISEPPE CARPANETTO, SHIHO HATTORI, ROBERT NASI
[1]MMU/CIFOR, Division of Biology and Conservation Ecology, M15 6BH, Manchester, United Kingdom
[2]Universidad de Malaga, Animal Biology, 29071, Malaga, Spain
[3]University of Florida, Geography, FL 32611, Gainesville, USA
[4]Hosei University, Faculty of Humanity and Environment, 102-8160, Tokyo, Japan
[5]Bioclimate, Research and Development, Livelihoods & Governance, EH1 1QW, Edinburgh, United Kingdom
[6]University College London, Anthropology, WC1H 0BW, London, United Kingdom
[7]Musée de l'Homme, Laboratoire Eco-Anthropologie et Ethnobiologie, 75116, Paris, Franc
[8]Universidad de Malaga, Animal Biology, 29071, Malaga, Spain
[9]Universidad de Malaga, Animal Biology, 29071, Malaga, Spain
[10]Universitat Autònoma de Barcelona, ICTA, 08193, Barcelona, Spain
[11]Universitat Autònoma de Barcelona, ICTA, 08193, Barcelona, Spain
[12]Università Roma Tre, Dipartimento di Scienze, 00154, Rome, Italy
[13]Tenri University, Faculty of International Studies, 632-8510, Tenri City, Japan

In the Congo Basin forests, the second most important tropical moist forest region of the world, bushmeat extraction levels have been of concern since they are considered unsustainable; around 5 million tonnes of wild mammal meat are extracted annually. The main driver for such scale of exploitation is commercial hunting, which has proliferated throughout the region. Commercial hunters extract a wide spectrum of wild species that are sold in towns and cities to a large number of consumers, who in fact have other alternative sources. Thus, continued extraction of wild meat at such levels will have enormous consequences on the food security of rural peoples and indigenous groups, i.e. Pygmies. In this paper, we first compare and contrast, from the published literature and unpublished data, the nature and frequency of hunting by Pygmy and non-Pygmy hunters in the Congo Basin. We then use these data to determine whether there are significant differences in the faunal extraction rates by these two groups. In the second half, we model and map the hunting pressure exerted by rural non-Pygmy hunters and Pygmy hunters throughout the Congo Basin forests. Finally, we reflect on whether sustainable hunting by indigenous peoples in tropical forests is possible, and whether wild meat extraction levels by indigenous people are compatible within conservation protected areas. This last point is of particular importance given the conflicts, real or perceived, that are typical, despite the surge in NGOs defending nature conservation and indigenous rights. Experience shows that the indigenous peoples rights and the biodiversity conservation movements have had a tradition of operating separately. In recent years, there has been much debate regarding whether and to what extent the conservation community has embarked upon a global biodiversity conservation effort that, as some observers say, excludes indigenous peoples in the process. We use empirical data and modeling to forward a more rational examination of the impact of subsistence hunting in forests in the Congo Basin.

O55-02 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

Hunting practices as drivers of small- and large-scale spatial variations in wildlife occurrence: an inter-site comparison across Central Africa

NICOLAS GAIDET[1], VLADIMIR GROSBOIS[1], CLEMENT HARDY[1], SÉBASTIEN LE BEL[1], JEAN-CHARLES SICARD[1], NATHALIE VAN VLIET[2], REMY FAGOT[1], FABRICE YAPI[1], ETIENNE GRANIER[1], FRANÇOIS SANDRIN[2], FRUCTUEUX HOUNGBEGNON[2], LILIANA VANEGAS[2], LUCILE BOUSSOLLE[2], JEAN-CLAUDE N'GUINGUIRI[3], ROBERT NASI[2], ALAIN BILLAND[1], DANIEL CORNELIS[1]
[1]CIRAD, ES, 34398, Montpellier, France
[2]CIFOR, Headquarters, 16115, Bogor, Indonesia
[3]FAO, Sub-regional Office for Central Africa, Batterie IV, Libreville, Gabon

Background: In a context of global biodiversity threat, overexploitation of wildlife populations through hunting is of major concern. Subsistence hunting, as a source of protein and incomes, is however a major component of livelihood for some local communities. The Congo basin in Central Africa is emblematic of these challenges, with rapidly declining wildlife populations in this biodiversity hotspot and the presence of rural populations relying on the exploitation of natural resources. The elaboration of sustainable hunting and management strategies is crucial but hampered by the lack of information on the impact of hunting on the status of wildlife populations. Measuring concurrently spatial patterns of wildlife occurrence and hunting activities at different sites along a gradient of hunting pressure may provide an important basis to identify indicators of non-sustainability of hunting.
Method: In this study, we implemented a standard protocol aiming at assessing the relationship between hunting practices and wildlife occurrence over 6 hunting grounds in the Congo Basin (Gabon, Congo, and Democratic Republic of Congo). Camera traps were deployed for a month over >300 sampling stations to detect the presence of elusive forest dwelling species. Socio-economic surveys were concurrently conducted in villages to map the contours and the principal features of every hunting ground, and characterize the management rules, hunting practices, offtakes and bushmeat consumption. The data collected by the camera traps were analysed using statistical models that estimate probabilities of occurrence of focal wildlife species at each station.
Result/Discussion: Our analysis identified the environmental and hunting related drivers of small- and large-scale spatial variations in occurrence for species belonging to these different indicator categories. Different categories of species were distinguished according to their potential as indicators of hunting pressure or practices. We discuss their respective relevance as a basis for implementing evidence-based wildlife management strategies through adaptive management.

O55-03 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

Bushmeat Hunting Risks Driving Large-bodied Animals to Extinction

DAVID WILKIE
WCS, Global Progam, 02451, Waltham, USA

Since the term bushmeat was coined in the conservation community over 20 years ago there has been growing concern that hunting wildlife for food in the tropics risks the loss of all large-bodied animals in the world's remaining tropical forests. As most of these species are important dispersers of the seeds of forest trees and vines, this presents a long-term threat to forest health.
Even in places where local people are merely hunting to feed their families optimal foraging theory predicts that bushmeat hunting will likely result in the extirpation of large-bodied species.
This presentation provides evidence that bushmeat hunters are optimal foragers and demonstrates that by targeting large-bodied, high-value to capture-cost ratio wildlife species and attempting to kill them whenever they are encountered, regardless of how infrequently, optimal foragers will drive large-bodied species to local extinction as long as there are sufficient small-bodied species to make bushmeat hunting worth their labor investment.
This presentation also offers options for avoiding the loss of large-bodied species in multi-species hunts of wildlife for food.

O55-04 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

Financial and economic values of bushmeat in rural and urban livelihoods in Cameroon: Inputs to the development of public policy

GUILLAUME LESCUYER[1], ROBERT NASI[2]
[1]CIFOR, GOV, 16115, Bogor, Indonesia
[2]CIFOR, DG, 16115, Bogor, Indonesia

Traditional wildlife hunting has been described mainly from studies of local practices and from the monitoring of urban bushmeat markets. However, the overall value chain connecting hunters to end consumers remains largely unknown, thus preventing any estimate of the actual socio-economic importance of the bushmeat sector. On the basis of existing literature, this paper provides an order of magnitude for the financial and economic benefits of the bushmeat commodity chain in Cameroon. The following conclusions were arrived at:
(1) The annual turnover of the bushmeat sector in the country is close to €97 million, i.e. 36% more than the official assessment derived from public accounts.
(2) The bushmeat sector contributes 0.17% to Cameroon's GDP (non-oil), as much as the mining sector.
(3) Self-consumption of bushmeat in rural areas amounts to gross annual economic benefit of more than €142 million.
However, bushmeat in a country like Cameroon needs to be managed so as to guarantee the food security of urban and rural populations, as well as maintain a substantial source of revenue for communities, all of this without depleting the resource. Achieving this goal requires policy makers to disassociate wildlife harvesting from 'poaching' and the extirpation of species. It is crucial to go beyond the dominant narrative of a (real but over simplified) notion of a conservation crisis, to address its important livelihood and welfare dimensions.

O55-05 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

The protection of traditional knowledge and subsistence rights of indigenous people and local communities

KARPE PHILIPPE[1], BOUTINOT LAURENCE[2], AUBERT SIGRID[3]
[1]Cirad, ES, Yaoundé, Cameroun
[2]Cirad, ES, 34398, Montpellier, France
[3]Cirad, ES, 34398, Montpellier, France

Mise en perspective historique des droits de chasse <=> un droit qui, depuis l'époque coloniale évolue entre «droit des indigènes, droit des commercants et intérêt général (quelle prise en compte des savoirs et des pratiques par le droit ? Ceci permet de contextualiser la problèmatique de la prise en compte des populations locales et autochtones dans la gestion des ressources cynégétiques
Engaging local communities into sustainable wildlife utilization practices fundamentally requires improving the rule of law, including strengthening the history, the knowledge and effectiveness of the law. How and to what extent can the recognition indigenous peoples' rights contribute to this objective in Central Africa? Which rights and for whose benefit?
The relevant international framework (Indigenous people rights declaration UN 2007 now recommends the general recognition of the right of indigenous peoples to self-determination, including their right be secure in the enjoyment of their own means of subsistence and development and their right to participate in local and national decision-making and management. It also obliges the recognition of their specific right to space and resources they have traditionally owned, occupied or otherwise used or acquired, according to their own customs and traditions.
This last right seems to be progressively recognized, especially because traditional ecological knowledges are now considered useful for sustainable development. For example, such recognition is now part of several standards of Forest Certification (eg FSC) of logging companies. But in many cases this seeming recognition of rights remains absolutely ambiguous in Central Africa. For instance, in Cameroon, both indigenous («Pygmies») peoples and their neighbors (subsumed under the generic term "Bantu") are compelled to integrate "Forests Peasants Committees" prior to legally benefit from their wildlife resources. Such committees remain however largely ineffective, mainly because the distribution of authority and roles between National Forest Service and logging companies is not clear in supporting them. Likewise, the discussions about the new wildlife and protected areas legal status of Central African Republic and the debate on the recognition of Indigenous and community conserved areas (ICCAs) in Democratic Republic of the Congo show that the contribution of indigenous peoples (and local communities) to sustainable wildlife utilization will be really useful on the s

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O55-06 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

The economic and food security impacts of the illegal bushmeat trade in African savannahs

PETER LINDSEY[1], ANDREW TAYLOR[2], VINCENT NYIRENDA[3]
[1]Panthera, Lion Program, 1018, New York, USA
[2]EWT, Trade in Wildlife Products, N/A, Johannesburg, South Africa(3) Capperbelt University, Department of Zoology and Aquatic Services, N/A, Kitwe, Zambia

The illegal bushmeat trade has long been known to be a key conservation issue in African forests, but until recently little was known about the extent of the problem in savannahs. There are increasing indications that the bushmeat trade represents a severe problem for wildlife populations and for wildlife-based land uses in savannah Africa. We assessed the economic and food security impacts of the bushmeat trade in African savannahs. We conducted literature reviews and case-studies to investigate the net economic and food security impacts of the bushmeat trade in southern Africa. This study highlighted how the illegal bushmeat trade generates livelihoods and meat for significant numbers of people in the region. However, these benefits are likely to be unsustainable and preclude the derivation of much more significant benefits from wildlife in the form of meat, jobs and revenue from tourism and trophy hunting. The bushmeat trade is an inefficient means of utilising wildlife because it is wasteful and unselective, because it depresses wildlife to levels where the derivable meat is limited, because it captures only one aspect of the value of wildlife and because it is typically unsustainable. Both of the case-study nations have severely depressed photographic tourism and trophy hunting industries as a result of the depression of wildlife populations through bushmeat poaching. If wildlife populations were allowed to recover to their potential in the two countries, hundreds of millions of dollars of additional income could accrue through photographic tourism and hunting, ~15 million kg more bushmeat could be produced and thousands of additional livelihoods could be created. However, communities currently choose to exploit wildlife for bushmeat because they are typically excluded from the benefits of legal use. There is thus an urgent need to develop frameworks that allow communities to extract benefits from legal utilisation of wildlife, and which attract private or donor investment to allow for the rehabilitation of wildlife areas.

O55-07 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

New technologies: mobile data collection system implication for wildlife management in Central Africa

FLORENCE PALLA[1], SÉBASTIEN LE BEL[2], DAVID CHAVERNAC[2], DANIEL CORNÉLIS[2]
[1]COMIFAC, OFAC, 20818, Yaoundé, Cameroun
[2]CIRAD, ES, 34398, Montpellier, France

If wildlife is considered as a renewable natural resource, for many rural Africans the occurrence of human wildlife conflict (HWC) overshadows expected outcomes from conservation and co-management initiatives. To reduce the magnitude of HWC, modern approaches deal with problem animals that cause conflicts while increasing the level of tolerance in the affected human populations. Assessing the local impact of HWC is part of this mitigation package, the objective been to provide timely information to adapt strategies and actions as data indicates what works and why. Lack of communication and trust between wildlife authorities and people concerned by HWC makes the effectiveness of the reporting poor, which raises the question of selecting the most appropriate technology for a real-time monitoring scheme with the capacity to inform decision-makers and improve the understanding of conflicts. To explore the feasibility of HWC monitoring, a series of tests was conducted in central Africa with KoBoCollect, an application from the KoBoToolbox an open source of tools for data collection and analysis based on OpenDataKit. With this application, data were collected using Smartphone on and off-line then synchronized into a database. Involving a regional HWC working group the 5W&H method was chosen to develop data trees of the key information needed to understand HWC problems. The 30+ variables were selected to develop an electronic form and responses to questions been facilitated by multiple choice responses with checkbox options. After a 9 month field test from April to December 2015, more than 300 electronic submissions were collected from Congo (42%), DRC (28%), Gabon (19%) and Cameroun (7%). Not surprisingly the elephant is the species most often involved in HWC (51%) followed by the hippo (11%) and rodents (11%), the other 11 species involved in HWC playing a minor role. If human casualties were rare (2%), the most predominant impact was crop raiding (82%). Mitigation measures were assessed according to the set of solutions of an existing HWC toolbox. Only making noise (33%) or fire (26%) appeared to be solutions mainly applied by local communities. Tested also to monitor hunting pressure in the same region KoBoCollect appears to be an easy to use tool to collect data at low cost in remote areas but questions remain on how to promote and popularize such an approach to fulfill management needs at landscape, national and regional levels.

O55-08 – S55 *Consumptive uses of wildlife in sub saharan africa: the janus bifrons syndrome*
Thursday 23 June / 08:00-10:00 – Einstein

community commercial conservancies as a valuable land use option in Southern Africa

CZUDEK RENE[1], LE BEL SÉBASTIEN[2], CORNELIS DANIEL[3]
[1]FAO, FAO Sub-regional Office for Southern Africa, -, Harare, Zimbabwe
[2]CIRAD, Environment & Societies, 34000, Montpellier, France
[3]CIRAD, Research Platform "Production and Conservation in Partnership", Harare, Zimbabwe

Southern African models of wildlife management are based on the devolution of wildlife management rights and benefits to private owners and communities. The guiding assumption behind these models is that wildlife management becomes more effective once local users are able to manage it and benefit from it. In recent decades, Namibia, South Africa, Zambia and Zimbabwe have decentralized state decision-making to local stakeholders, thus enabling them to benefit from numerous opportunities offered by the wildlife tourism industry, especially trophy hunting (a high-value-added activity). This approach has been particularly successful on commercial farmlands, where substantial areas have been converted to game ranches that generate profits mainly through trophy hunting but also through live animal sales, ecotourism and game meat production, among others. Although making good profits while conserving wildlife and providing social and economic benefits in rural areas, commercial wildlife ranches have been often perceived as "While only" elite businesses, resulting in some cases in serious political and land tenure tensions.
The decentralization approach has been less straightforward on communal lands because communal property regimes (in which defined groups may collectively exploit common resources within a defined jurisdiction) need to be established. Community-based wildlife management approaches were initiated successfully in Zimbabwe in the early 1990s under the CAMPFIRE programme, although these were later hampered by political developments. Other countries have also adopted community-based wildlife management approaches. In Namibia, for example, communal area conservancies are proving to be highly successful in a context of low human population density. There is a need however, to develop community commercial conservancy as a wildlife-based land use option in the more general context of Southern African populated communal lands.
In this communication, we promote the idea of developing models of multi-purpose wildlife use and trade as a development tool offering alternative livelihood options for rural communities living in marginal areas rich in wildlife. Tacking this challenge will require a supporting the revision of decentralization processes, adapting legal frameworks, and developing innovative business models involving effective public-private partnerships.

O56-01 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

What is the carbon balance of tropical managed forests?

BRUNO HÉRAULT[1], CAMILLE PIPONIOT-LAROCHE[2]
[1]Cirad, UMR EcoFoG, 97310, Kourou, French Guiana
[2]Universite de Guyane, UMR EcoFoG, 97310, Kourou, French Guiana

Managed forests are a major component of tropical landscapes and almost half of standing primary tropical forests, up to 400 million ha, are designated by national forest services for timber production. However, so far, most of our understanding of the tropical forest carbon cycle yields is from plot networks located in old-growth undisturbed forests while the carbon balance of managed forests at the regional and continental scale remains poorly studied. Here we propose a methodological framework in order to quantify the carbon footprint of selective logging at a regional scale. The yearly balance of a logged forest unit is modeled by aggregating 3 sub-models dealing with (i) emissions from extracted wood, (ii) emissions from logging damages and (iii) storage from biomass recovery after logging. Models are parameterized and uncertainties are propagated through a MCMC algorithm. We used the 30-years statistics from the National Forest Service to estimate the carbon balance of managed forests in French Guiana. Over this period, selective logging emitted 0.76 Tg C in the atmosphere. Our results highlight the key role of the local carbon cycle in managed forests for climate regulation at the global scale.

O56-02 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Effects of logging on forest stand carbon recovery and tree biomass

ERVAN RUTISHAUSER[1], BRUNO HÉRAULT[2], PLINIO SIST[1]
[1]CIRAD, UR B&SEF, 34000, Montpellier, France
[2]CIRAD, UMR EcoFoG, 97387, Kourou, Guyane Française

We will present recent findings arising from the Tropical managed Forests Observatory. Results from the first regional analysis of above-ground carbon stocks dynamics post-logging in Amazon managed forests will be presented. We found that the percentage of initial carbon lost during logging was the main driver of post-logging dynamic, enabling on his own to accurately predict time of recovery wherever in the Amazon Basin.Moving from forest stand to tree responses, we show how logging, by releasing competition for light, may affect trees morphology. We found a significant reduction of both total and bole heights proportional to logging intensity in a tropical logged forest in French Guiana. This resulted in a 10-13% reduction of tree biomass and timber volume.
These results will be discussed in terms of future management and provision of ecosystem services in tropical production forests.

O56-03 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Modelling aboveground biomass dynamics in Amazonian selectively logged forests

CAMILLE PIPONIOT-LAROCHE[1], LUCAS MAZZEI[2], ERVAN RUTISHAUSER[3], PLINIO SIST[4], BRUNO HÉRAULT[5]
[1]Université de Guyane, UMR EcoFoG, 97310, Kourou, French Guiana
[2]Embrapa, Amazônia Oriental, Belém, Brazil
[3]CarboForExpert, Hermance, Switzerland
[4]Cirad, UR BSEF, 34398, Montpellier, France
[5]Cirad, UMR EcoFoG, 97310, Kourou, French Guiana

Large areas (2 million hectares per year) of Amazonian forests are selectively logged in a polycyclic harvest system. Modeling the post-logging dynamics of these production forests is thus of primary importance to assess their future carbon storage capacity as well as the structural and dynamic features of the forest that will be found in the next logging cycle. In this study, we used a network of 100 permanent sample plots in 10 sites spread across the Amazon basin to model three post-logging biomass fluxes (recruitment, growth and mortality). The temporal evolution of these biomass fluxes (recruitment, growth and mortality) for surviving trees and recruits and their relative importance in explaining biomass recovery through the Amazonian basin were modeled taking into account spatial as well as temporal autocorrelation in a mixed model framework. Incorporating both the environmental variability and the logging characteristics in the developed model indicate that the two key drivers of post-logging biomass fluxes are the relative biomass loss due to logging and the initial aboveground biomass. Overall, environmental factors had little additional weight in explaining the Amazon-wide variations of post-logging biomass fluxes. Our results stress the importance of developing specific modelling frameworks to account for the peculiar carbon cycle in managed tropical forests in order to better recognize their key role for climate regulation at the global scale.

O56-04 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Deadwood in logged-over Dipterocarp forests of Borneo

ANDES ROZAK[1], PLINIO SIST[3], ERVAN RUTISHAUSER[4]
[1]Indonesian Institute of Sciences (LIPI), Cibodas Botanic Gardens, 43253, Cianjur, Indonesia
[2]AgroParisTech, 34093, Montpellier, France
[3]Cirad, BESEF, 34398, Montpellier, France
[4]CarboForExpert, 1211, Geneva, Switzerland

Deadwood is an important stock of carbon in logged-over Dipterocarp forests but still remains poorly studied. Here we present the study of deadwood in logged-over Dipterocarp forests using two common approaches: plot-based approach and line-intersect-based approach.
We conducted our research in three sites which are forest logged in 2003, 2007, and 2010 within Hutansanggam Labanan Lestari (HLL) forest, a certified forest concessionaire in Indonesia. We established 1,500 m of transect line (broken down in 50 m section) for each site. As a reference, we established 47 10 m x 10 m subplot for three sites. All fallen deadwood with diameter > 10 cm were recorded. Our results shows that the mass of fallen deadwood resulted by line-intersect-based method was much higher in compare to plot-based method. The mass of fallen deadwood in plot-based study (44.563 ± 9.155 Mg/ha) was significantly different with the mass of fallen deadwood in line-intersect-based study (69.587 ± 8.079 Mg/ha). Furthermore, for the variability of deadwood, both methods show consistence results which is the variability in 2003 was lower than that in 2007 and 2010.
Based on our data, in order to get coefficient of variation of 10%, we recommend the use of minimum 40 plots of 20 m x 20 m to estimate deadwood in logged-over Dipterocarp forests.

O56-05 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Effects of disturbance intensity and tree diversity on the biomass recovery of a managed tropical forest

ANGELA L. DE AVILA[1], MASHA T. VAN DER SANDE[2], CARSTEN F. DORMANN[3], LUCAS MAZZEI[4], ADEMIR R. RUSCHEL[4], JOÃO O. P. DE CARVALHO[5], JOSÉ N. M. SILVA[5], LOURENS POORTER[2], MARIELOS PEÑA-CLAROS[2], JUERGEN BAUHUS[1]
[1]University of Freiburg, Chair of Silviculture, 79085, Freiburg, Germany
[2]Wageningen University, Forest Ecology and Forest Management Group, PO Box 47, 6700 AA, Wageningen, The Netherlands
[3]University of Freiburg, Biometry and Environmental System Analysis, 79106, Freiburg, Germany
[4]Embrapa Amazônia Oriental, Forest Management Group, Caixa Postal 48, 66095-100, Belém, Pará, Brazil
[5]Universidade Federal Rural da Amazônia, Av. Presidente T. Neves, 2501, Montese, 66066077-53077-530, Belém, Pará, Brazil

Sustainable forest management requires that forest ecosystem properties and processes can recover between major management-related disturbances to permit long-term ecosystem functioning. It remains, however, unclear how disturbance regimes and tree community properties influence the resilience of diverse tropical forests. In this study, we investigated how management-related disturbance intensity, remaining tree species diversity and community-mean trait composition affect recovery rates, measured as the annual increment of aboveground biomass, as a proxy for resilience. The study was conducted in a long-term experiment established in 1981 to study the effects of different management intensities and interventions on forest dynamics. The experimental site is located in the Tapajós National Forest, Pará, Brazil. Interventions comprised logging (1982), damage to trees not harvested (i.e., trees that died as an indirect result of logging) and thinning (1993 to 1994). We considered two recovery periods: post-logging (1983-1989) and post-thinning (1995-2012). Trees with diameter at breast height greater than or equal to 10 cm were measured on eight occasions in 41 plots of 0.25 ha. Remaining diversity and community-weighted mean trait values were calculated for the post-intervention censuses (i.e., 1983 and 1995). Predictors were related to biomass recovery rates using structural equation modelling. In both periods, biomass recovery rates of surviving trees increased with basal area remaining, and recovery rates of recruit trees increased with disturbance intensity. We found a weak signal for positive effects of remaining diversity and community-weighted mean trait values on recovery rates. Biomass recovery was strongly determined by disturbance intensity regarding the proportion of basal area remaining. Consequently, strong harvesting and thinning interventions should be avoided to reduce negative effects on productivity and carbon sequestration, as well as on other ecosystem functions which have not been investigated here.

O56-06 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Species richness and ecosystem stability control carbon use efficiency of tropical forests

NORBERT KUNERT
Max Planck Institute for Biogeochemistry, Biogeochemical Processes, 07745, Jena, Germany

Tropical forests are characterized by their high photosynthetic activity; however results from pantropical studies show that only 30% of the products from photosynthesis are allocated to new biomass compared to 50% in temperate systems. Mechanisms explaining this low carbon use efficiency (CUE) in tropical forests are still missing. I present a synthesis of studies from two tropical sites with a similar methodological set up to evaluate the ecophysiological responses of tree communities to diversity effects and forest disturbance. Xylem sap flux derived gross primary productivity (GPP) was modelled using eddy covariance data. This was done for a forest plantation with plots of varying tree species diversity in Panama and an old-growth forest with a distinct disturbance gradient in an Amazonian moist lowland forest. Information on net primary productivity (NPP) was calculated from inventory data. The multiple scale analysis provides evidence that GPP increases with tree species richness, but stays relatively stable with forest disturbance intensity. However, CUE decreases with tree species richness, but increases with forest disturbance intensity. Thus, the high diversity of tropical forests and the steady state conditions of tropical old growth forests might explain their low CUE.

O56-07 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Seeing the woods through the saplings: using wood density to assess post-disturbance recovery of human-modified tropical forests

ERIKA BERENGUER[1], TOBY GARDNER[2], JOICE FERREIRA[3], LUIZ ARAGÃO[4], RALPH MAC NALLY[5], JAMES THOMSON[5], IMA VIEIRA[6], JOS BARLOW[1]
[1]Lancaster University, Lancaster Environment Centre, LA14YQ, Lancaster, UK
[2]Stockholm Environment Institute, Stockholm Environment Institute, Box 24218, Stockholm, Sweden
[3]Embrapa Amazônia Oriental, Embrapa Amazônia Oriental, 66095-100, Belém, Brazil
[4]Instituto Nacional de Pesquisas Espaciais, Remote Sensing Division, 12227-010, São José dos Campos, Brazil
[5]University of Canberra, Institute for Applied Ecology, ACT 2617, Bruce, Australia
[6]Museu Paraense Emílio Goeldi, MCT, 66017-970, Belém, Brazil

Most of the world's humid tropical forests have already been modified by human activities such as selective logging, understory fires, and clear-felling. Despite the ubiquity of these human-modified forests, we have a limited knowledge of their potential to recover key traits linked to ecosystem functioning. Here we propose a novel approach to further our understanding of tropical forests recovery to human-driven impacts. We analyze the wood density of trees and saplings in 121 plots (0.25ha each) located across a disturbance gradient in the eastern Brazilian Amazon. Wood density (wd) is a key plant trait, closely linked to important ecosystem functions and services, such as carbon storage. Saplings respond faster to human impacts than large trees and effectively represent the future of a forest stand, thus allowing us to make valuable inferences about the future ecological state of a forest. We combined the analysis of 31,095 stems with a 22-year chronosequence of satellite imagery data and plot-level environmental variables, including recovery time of forest plots, distance to the nearest forest edge, density of lianas, the amount of surrounding forest cover, soil clay content and mean plot slope. We found that wood density of saplings in undisturbed primary forests (wd = 0.70; SE = ±0.004) is significantly higher than in disturbed primary forests (wd = 0.59; SE = ±0.007) and in secondary forests (wd = 0.58; SE = ±0.016), indicating that the human-modified forests of the future may present a different set of traits, and therefore perform a different set of functions, than the future undisturbed forests. We also found that forests located less than 130m away from human-made edges or with high density of lianas (≥900 stems per hectare) may be impeded in their recovery from disturbance or clear-felling. These results indicate that future human-modified tropical forests may hold less carbon than currently expected. We urge scientists, governments and the civil society alike to start addressing the cryptic but severe impacts of human disturbances in remaining areas of standing primary forests and regenerating secondary forests.

O56-08 – S56 *Towards refined carbon budgets of managed forests*
Thursday 23 June / 14:30-17:00 – Einstein

Xtrawood: refining estimation of tree above ground biomass using wood specific gravity variations and tree structure

ROMAIN LEHNEBACH[1], HÉLÈNE MOREL[2], JULIE BOSSU[3], JACQUES BEAUCHÊNE[2], ERIC NICOLINI[4], JEAN-FRANÇOIS BARCZI[1], SÉBASTIEN GRIFFON[1]
[1]CIRAD, JRU AMAP, botAny and Modelisation of Plant Architecture and vegetation, 34398, Montpellier, France
[2]CIRAD, JRU EcoFoG, Ecology of Guianan Forest, 97310, Kourou, France
[3]CNRS, JRU EcoFoG, Ecology of Guianan Forest, 97310, Kourou, France
[4]CIRAD, JRU AMAP, botAny and Modelisation of Plant Architecture and vegetation, 97310, Kourou, France

Background: Tree above ground biomass (AGB) is currently estimated by tree-level allometrical models that take into account, tree volume estimated from proxy variables of tree size (DBH) and species average wood specific gravity (WSG). These methods are common and realistic from a practical point of view. However, they do not take into account deviance from fixed allometrical trajectories and spe-cies or tree level WSG variations. Here, we present Xtrawood software that allows computation of tree AGB according to structure and WSG variations.
Method: Xtrawood reconstructs tree structure and integrates WSG variations by merging tree structure and WSG data measured at different position in trees, leading to the computation of global AGB and visualization of WSG variation along tree structure. Tree structure is measured according to stem dimensions (length, diameter) and positions within tree, and encoded in Multiscale Tree Graph format (MTG). WSG data is made of radial WSG profiles (1 measure each 0,5 cm from pith to bark) sampled at different heights within whole tree. Xtrawood output are illustrated using a dataset collected on an Amazonian forest 'biomass dominant species', Dicorynia guianensis Amsh., also known to exhibit substantial WSG gradients along both radial and vertical axis. 9 trees ranging from 15 to 60 cm DBH were measured by climbers. Each tree was felled and samples were collected at different positions (3 in trunk, 1 to 5 in crown) to record WSG radial profiles.
Results: Xtrawood allows computation of tree volume, but also visualization of WSG variations in tree as well as inference of WSG radial profiles at different heights. Output variables are decomposed according to different tree scale and locations (axis, trunk/crown) and easy to extract. Xtrawood results will be compared to those of standard estimation method and can be used to identify positions in trees where WSG value leads to the better estimate of tree AGB.
Conclusion: Xtrawood produces AGB estimate with data from intensive measurements practices. The sampling protocol, used here, remains destructive and time-consuming because Xtrawood is not directly dedicated to forest managers, but to help calibration of realistic sampling strategies. Moreover, Xtrawood offers a way to understand relationships between tree development, WSG variations within tree structure and biomass accumulation in the context of natural forests or plantations. A software demo is available at coffe break.

O57-01 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Species coexistence, inter- and intraspsecific trait variation in a tropical forest

CYRILLE VIOLLE
CNRS, Centre d'Ecologie Fonctionnelle et Evolutive, 34293, Montpellier, France

The incorporation of functional traits in community ecology has recently led to crucial advances in the understanding of community assembly rules. However, intraspecific trait variation still needs to be accounted for, despite its theoretical importance in species coexistence theory. Individual is the fundamental unit of ecological interactions. Therefore, intraspecific variation can help us to better understand assembly processes shaping ecological communities. In that purpose, we used variance decomposition and ratios of variances at different organizational levels for 19 traits measured in 4671 individuals belonging to 668 species in a tropical rainforest. Combined with null models, these methods allowed us to (i) quantify the relative importance of intra- and inter-specific variations for the assemblage of communities of tropical trees, (ii) test the relevance of individual-centred community ecology for the coexistence of tropical trees and (iii) infer underlying community assembly mechanisms. Intraspecific trait variance is large (39 % on average) including features often averaged by species only in the ecological literature (e.g. specific leaf area and canopy height). Species undergo no filter while individuals undergo an external filter, mainly captured by delta 15N in leaves. In addition, 16 traits are involved in the internal filter of the community, particularly traits associated with resistance / tolerance to herbivory. These results highlight the importance of intraspecific variation in the assembly of tree communities.

O57-02 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Variation in allocation vs. organ level traits in tropical seedling communities in tropical China and Puerto Rico.

MARIA NATALIA UMANA[1], CAICAI ZHANG[2], MIN CAO[2], LUXIANG LIN[2], NATHAN SWENSON[1]
[1]University of Maryland, Biology, 20742, College Park, USA
[2]Chinese Academy of Sciences, Xishuangbanna Tropical Botanical Garden, 650223, Kunming, China

Community assembly is the result of individual-level interactions with the environment and how these interactions vary within and across populations and species. Uncovering the role of intra- and inter-specific trait variations represents a major challenge for understanding the forces dictating individual interactions that drive community structure and dynamics. Here we aim to evaluate the role intraspecific allocation-related and organ-level traits and its contribution to functional beta diversity across seedling communities and how it is linked to trait variation partitioning across three ecological levels (among species, populations and individuals).
The work was accomplished by measuring allocation, organ-level traits and growth rates on thousands of individuals in two seedling censuses in Puerto Rican and Chinese rainforests. Functional beta diversity analyses and variance partitioning analyses were implemented at three ecological scales (species, populations and individuals).
We found that the inclusion of individual level traits increased trait dispersion within and between seedling communities and this effect was magnified for allocation related traits. Consistent with this, we found that the majority of the variation in allocation related traits was between conspecific individuals in populations rather than between species while most of the variation in organ level traits were found between species. Thus, environmental context dependency in phenotypes was highest in allocation traits indicating that adjustments in allocation likely plays a large role in dictating of intra- and inter-specific interactions within and across communities.
In sum, our results show that the increases in trait dispersion due to intra-specific variation are not only happening at local scales, but functional turnover between local assemblages increases due to intra-specific variation. In addition, we found that the functional turnover is linked to two major phenotypic axes of variation, allocation and organ-level traits, that constitute two contrasting strategies for responses to biotic and abiotic contexts: one, highlights ecological differences among individuals, the other highlighting ecological differences among species. Considering only one of these two trait types would lead to an incomplete understanding of community dynamics.

O57-03 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Disentangling different sources of intraspecific functional trait variation in a subtropical rain forest

I FANG SUN, E PING RAU
National Dong Hwa University, Natural Resources and Environmental Studies, 97401, Hualien, Taiwan

Background: In recent year, many studies have demonstrated that intraspecific trait variation (ITV) accounts for a considerable portion of total trait variation, significantly influences the outcome of competition and may play an important role in processes of community assembly. Intraspecific trait variations can arise from several possible sources, such as genetic variation between individuals, phenotypic plasticity in response to environmental conditions and ontogenetic change over developmental stage.
Method: In order to understand the contribution of different sources of intraspecific trait variation and its implication on community assembly, we conducted a community-wide study by collecting leaf traits of the same individuals from 22 tree species in 2009 and 2014, respectively, in a subtropical rain forest in Fushan Forest Dynamics Plots, Taiwan.
Result: Our preliminary results showed that interspecific trait variation was considerably larger than intraspecific trait variation in the Fushan forest community; however, both ITV arising from individual difference (genotype) and between-year difference (phenotypic plasticity) were still shown to be significant, indicating that they are likely to play a role in community assembly and other processes. In addition, detailed analysis showed that the source of ITV varied considerably between each species, but ITV was contributed mainly by individual difference. Furthermore, phenotypic plasticity appeared to have high consistence across traits: species with higher plasticity for one trait tend to have higher plasticity in other traits as well.
Discussion/Conclusion: The fact that phenotypic plasticity contributed less in ITV than genotypic variation in Fushan tree community suggest that environmental conditions may have a strong filtering effect on trait variation. Another possibility is that environmental change was not large enough between the two sampling period (5 years) to produce significant, observable plastic response for these traits. Both hypotheses require further investigation, and more refined environmental data would be needed to directly link trait variations to plastic response to environmental conditions.

O57-04 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Evaluating the contribution of ontogeny to intraspecific variability in functional traits of tropical trees

CLAIRE FORTUNEL[1], NTHAN J.B. KRAFT[1], NATALIA NORDEN[2], C.E. TIMOTHY PAINE[3]
[1]University of California, Los Angeles, Department of Ecology and Evolutionary Biology, 90095-1606, Los Angeles, USA
[2]Instituto Alexander von Humboldt, --, 3202767, Bogota, Columbia
[3]University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, UK

Background: Trait-based ecology has primarily focused on mean trait values of co-occurring species to make inferences about the role of different community assembly mechanisms. Yet an increasing body of literature has argued for accounting for intraspecific trait variation (ITV), as traits exhibit variation within a given species. ITV has recently been shown to account on average for 25% and 32% of trait variation within and among plant communities respectively, which could have substantial consequences for community assembly at local scales. A challenge to better understand community response to global change is to evaluate the contribution of ontogeny to ITV. Here we focus on the contribution of ontogeny to ITV in tropical tree species and how variation in trait differences between ontogenetic stages can influence species interactions.
Method: We compile trait data for seedlings, saplings and adults of tree species across several tropical forests. To evaluate what percentage of ITV is due to ontogeny in tropical species, we use linear mixed models with ontogenetic stages as fixed factors, and species and site as random effects. To test if trait differences among tropical species vary with ontogeny, we examine if ranked values of species traits vary between ontogenetic stages at each site. Lastly we determine whether tropical species and site exhibit similar magnitude of ontogenetic change in traits.
Result: Preliminary results in one site reveal strong ontogenetic changes of traits in tropical trees. In particular, specific leaf area decreases as trees are growing, while leaf size, thickness and toughness show the opposite pattern. Species rankings tend to be conserved among ontogenetic stages, although species show some variation in the magnitude of ontogenetic change.
Discussion/conclusion: Ontogeny strongly contributes to ITV in tropical tree species. Interspecific trait hierarchies are maintained between ontogenetic stages, yet the magnitude of ontogenetic change among co-occurring species varies between species. The latter could play a substantial role in species interactions, in particular for early ontogenetic stages. Further studies require additional data to evaluate the contribution of ontogenetic ITV to species dynamics, in particular in local neighborhood interactions.

O57-05 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Is within-canopy variation of leaf functional traits more important than intraspecific variation in tropical forest canopies?

MOLLY CAVALERI, ADAM COBLE
Michigan Tech, School of Forest Resources and Environmental Science, 49931, Houghton, USA

Leaf morphological traits like leaf mass per area (LMA) are used to model whole-forest canopy function due to strong within-canopy correlations with physiological traits including photosynthetic capacity, leaf respiration, leaf carbon isotope composition (δ13C), and leaf nutrients. Vertical distributions of these traits can be attributed to either light gradients, seasonal changes, hydrostatic limitations, or a combination of all three. Here, we analyze multiple datasets of vertical canopy gradients in leaf functional traits across Hawaii, Brazil, Costa Rica, and Puerto Rico, including 100+ tree species. We synthesize data to investigate vertical patterns in morphological and physiological leaf traits, test hypotheses about underlying mechanisms, and synthesize data to reveal broader patterns of canopy process. Our data are consistent with the hypothesis that hydrostatic constraints on leaf morphology drive the vertical increase in LMA for evergreen species. However, for seasonal deciduous species, light tends to be the primary driver as a result of within-season light acclimation, especially in the upper canopy. Additionally, models with no representation of vertical variation in leaf traits (e.g., Big Leaf models) can overestimate canopy photosynthesis by up to 60% throughout the season. We found that it is also important to incorporate stomatal behavior when scaling to the canopy. Taking gradients of intracellular CO_2 (estimated from δ13C) into account when modeling canopy photosynthesis drastically altered the model estimate of carbon assimilated from the upper quarter of the canopy. The top 25% of the foliage assimilated 50% of the total carbon when Ci was not taken into account, but only ~25% when Ci was taken into account. Our results suggest that that tropical forests show convergent, predictable patterns in multiple morphological and physiological leaf traits with height, and that the mechanisms behind these gradients point primarily to hydrostatic constraints, especially in evergreen leaves. In addition, ignoring this vertical variation of key traits can lead to considerable bias of whole-canopy photosynthesis estimates, regardless of species.

O57-06 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Does intra-specific variation prevent division of tropical trees into drought sensitive and resistant groups?

LUCY ROWLAND[1], PATRICK MEIR[2], MAURIZIO MENCUCCINI[3], ANTONIO DA COSTA[4], OLIVER BINKS[5], RAFAEL OLIVEIRA[6], LINA MERCADO[7], STEEL VASCONCELOS[8], ALEX OLIVEIRA[9], BRADLEY CHRISTOFFERSEN[10], LEANDRO FERREIRA[11], JOHN GRACE[12], STEPHEN SITCH[13]
[1]University of Exeter, Geography, EX4 4RJ, Exeter, UK
[2]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK
[3]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK
[4]UFPA, Geosciences, 66075-110, Belem, Brazil
[5]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK
[6]UNICAMP, Instituto de Biologia, 13083-862, Campinas, Brazil
[7]University of Exeter, Geography, EX4 4RJ, Exeter, UK
[9]Museu Paraense Emilio Goeldi, Ecologia, 66040-170, Belem, Brazil
[10]LANL, Cliamte Reserach, MS-J495, Los Alamos, USA
[11]Museu Paraense Emilio Goeldi, Ecologia, 66040-170, Belem, Brazil
[12]University of Edinburgh, Geosciences, EH9 3FF, Edinburgh, UK(8) EMBRAPA, Amazonia Oriental, 66095-903, Belem, Brazil
[13]University of Exeter, Geography, EX4 4RJ, Exeter, UK

Tree diversity in tropical rainforests is higher than in any other forest in the world. Accurate simulation in dynamic global vegetation models (DGVMs) of the response to drought by these forests is of great importance because tropical forests substantially affect our climate and atmosphere. As DGVMs cannot simulate the full spectrum of variation amongst tropical trees, and research is therefore needed to test how best to simplify both intra- and inter-specific variation, but represent the key processes with sufficient accuracy. Using data from the world's longest running tropical rainforest through-fall exclusion experiment (TFE) we raise the issue of whether it is feasible to view tropical trees in the context of being either sensitive or resistant to drought-induced mortality at the scale of land-surface models used for coupling in Earth system model frameworks. Using data from taxa sorted into drought sensitive and drought resistant functional groups, we show drought responses to be mediated by key plant functional traits. However, despite a clear division in drought responses between species according to their drought sensitively, we find that tree size is a key factor introducing intra-specific variation in drought-induced mortality risk. These results suggest new tropical forest plant functional types are a useful framework for revising DGVMs, if the effect of tree size can be accounted for.

O57-07 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Intraspecific variation of seedling drought resistance across a strong rainfall gradient at the Isthmus of Panama

BETTINA ENGELBRECHT[1], ERIC MANZANE[2], LEONOR ALVAREZ-CANSINO[1], ANDY JONES[3], LIZA COMITA[4]
[1]University of Bayreuth, Bayreuth Center for Ecology and Environmental Research, Bayreuth, Germany
[2]Smithsonian Tropical Research Institute, Panama, Panama
[3]Oregon State University, Department of Botany and Plant Pathology, Corvallis, U.S.A.
[4]Yale University, School of Forestry, Yale, U.S.A.

Background: Intraspecific variation, arising from both genetic variation and phenotypic plasticity, can significantly influence ecological dynamics and species' responses to climate change. In tropical forests, which are predicted to experience pronounced changes in rainfall patterns, the existence and extent of intraspecific variation in species' environmental tolerances remains poorly understood.
Methods: We are employing an interdisciplinary approach, combining tools from plant physiology, and community ecology, to assess intraspecific variation of drought resistance in 14 focal species, using a steep natural rainfall gradient in central Panama as a model system. Specifically, common garden and reciprocal transplant experiments are combined with measurements of physiological traits directly relevant for plant drought resistance, as well as with studies of genetic structure and gene flow (see talk in session 'next generation forest science').
Results: Data from the first year indicate that intraspecific variation of seedling drought resistance across the pronounced rainfall gradient is minimal: seedlings of different origin did not vary in mortality in a common garden drought experiment, seedlings did not have a home advantage compared to foreign seedlings in a reciprocal transplant experiment across the rainfall gradient, and physiological traits related to plant drought resistance did not vary among origins in a way consistent with adaptive intraspecific variation.
Discussion/Conclusions: Intraspecific differences in drought resistance of populations of different origins across the rainfall gradient may only play out under extreme drought conditions, such as those currently experienced under El Niño conditions, and expected more frequently with climate change. The currently ongoing extreme El Niño event will allow us to evaluate this possibility. Additionally, or alternatively, high gene flow may minimize the potential for genetic and associated trait differentiation among populations. This would imply a low potential for in situ adaptation to higher frequency and intensity of drought with climate change.

O57-08 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Intra- and interspecific variation in wood functional traits of tropical trees

PETER HIETZ, SUSANNE SCHEFFKNECHT
University of Natural Resources and Life Sciences (BOKU) Vienna, Institute of Botany, 1180, Vienna, Austria

Wood functional traits are important for growth, drought resistance, storage, water transport capacity and defence. They have been related to environmental variables such as water supply, but also to ontogenetic factors such as tree size. Interpreting the adaptive significance of any differences observed is thus problematic if we compare sites with trees of different sizes or species compositions. To overcome these problems, we selected pairs of trees from different sites controlling for tree size and species composition and compared wood specific gravity, wood anatomy, theoretical hydraulic conductivity and implosion resistance of vessels. Pairs were either conspecifics growing in Central American dry and wet forests, congenerics growing in dry or moist forests, or congenerics that preferentially grow in either drier or wetter forests across the Panama isthmus but were all sampled from the moist forest around Barro Colorado Island (BCI). First, differences among species within a forest are much larger than differences between forests, so that the adaptive significance of individual traits to climate appears to be moderate, at best. Second, differences within a tree, particularly related to tree size, can be substantial so that tree size should be accounted for when comparing forests. We found almost no difference in wood traits between individuals of the same species growing in wetter or drier forests. By contrast, different species from the same genus growing in dry forests tend to have smaller vessels (lower hydraulic conductance) and higher implosion resistance (thicker cell wall to lumen span ratios), and wood traits of species growing in the same climate around BCI are related to the species' adaptations to drier or wetter forests. This suggests that wood traits adapt to water supply during speciation, but a limited capacity for adaptations within a species.

O57-09 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Let the botanical gardens be functional

BELEN FADRIQUE[1], CATHERINE BRAVO[1], TIMOTHY PEREZ[1], MICHAEL RANKIN[1], JESSICA RODRIGUEZ[1], ANA ROJAS[1], CHRISTOPHER BARALOTO[1], KENNETH FEELEY[2]
[1]Florida International University, International Center for Tropical Botany, Department of Biological Sciences, 33199, Miami, US
[2]Fairchild Tropical Botanic Garden, 33156, Coral Gables, US

Background: Functional traits represent a powerful tool for investigating patterns of plant community assembly and the effects and consequences of global change. Trait data has become available for thousands of plant species; however, data are still missing for the vast majority of species and few species have data for multiple traits. One factor limiting our ability to collect functional trait data for more species is the difficulty of finding and identifying multiple individuals of each species. The living plant collections of botanical gardens can minimize these problems by providing easy access to replicates of hundreds of species of verified identity. Despite these advantages, botanic gardens are a highly underused research resource.
Method: In order to test the potential value of botanic gardens as sources of functional trait data, we compared leaf trait data measured on 18 species growing in the Fairchild Tropical Botanic Garden (FTBG), Miami USA, with values available in the TRY public trait database.
Result: SLA values as measured at FTBG were very highly correlated with the mean SLA values available through TRY (slope=1.0, R2=0.65). Moreover, FTBG provided a better representation of mean SLA values than any of the field sites at which analogous tests had been conducted.
Conclusion: These results demonstrate how botanic gardens can be a valuable tool for the collection of functional traits in taxonomically and geographically disparate species. Furthermore, research on living collections can enhance the functionality of botanic gardens by strengthening the foundation for education and outreach programs.

O57-10 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Microgeographic adaptation in tree stands

SCOTTI IVAN
IVAN SCOTTI[1], NIKLAS TYSKLIND[1], CAROLINE SCOTTI-SAINTAGNE[2], LOUISE BROUSSEAU2, HADRIEN LALAGÜE[1]
[1]NRA, EcoFoG, 97387, Kourou, French Guiana
[2]INRA, URFM, 84914, Avignon, France

Trees are long-lived, large-sized organisms capable of long distance propagule dispersal. Thus, the neutral theory of biodiversity predicts that their distribution patterns must be driven by neutral processes. Does this leave any room for local, and even microgeographic (i.e. within stand) adaptive processes? We contend that, of all ecosystems, tropical rainforests are among the most likely to show such processes: starkly contrasted habitats can coexist over short geographical distances, and the potential for selective ecological filtering is strong, as suggested by the observed abrupt transitions between floristic assemblies among habitats. Signatures of microgeographic adaptation can be sought in populations of generalist species, which colonise multiple habitats. We argue that, if adaptation underlies habitat specialisation, then subpopulations of generalist species must also show signs of adaptation to each of the habitats it occupies locally. Results on multiple tree species, studied in the Guiana Shield, show high levels of within-stand, potentially adaptive diversity. Such phenotypic and molecular diversity (including gene expression) is at least partly structured by sharp ecological contrasts occurring over short geographical distances. After discussing these results, we will also shortly present ongoing projects aiming at comparing results on local adaptation obtained throughout the Tropics.

O57-11 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Insights into the adaptability of tropical trees from Hawaii's landscape dominant, Metrosideros polymorpha

ELIZABETH STACY[1], JENNIFER JOHANSEN[1], JILL EKAR[1], TOMOKO SAKISHIMA[1], KEENAN MORRISON[2], ALICIA RHOADES[1], DONALD PRICE[1], YOHAN PILLON[3]
[1]University of Hawaii Hilo, Tropical Conservation Biology and Environmental Science, 96720, Hilo, USA
[2]University of Califormia Riverside, Biology, 92521, Riverside, USA
[3]University of Limoges, Faculte des Science et Techniques, 87032, Limoges, France

Background: Metrosideros polymorpha is a hypervariable, landscape-dominant tree species in the Hawaiian Islands that spans 2,500 meter in elevation, wet and dry forests, bogs, deserts, and wind-swept cliffs. Early studies attributed the ecological breadth and contrasting vegetative traits of the species' eight recognized varieties to phenotypic plasticity.
Methods: We examined neutral genetic divergence, differential adaptation at the seedling stage, and reproductive barriers among varieties of M. polymorpha using nuclear microsatellites, field and greenhouse experiments, and hand-crosses, respectively.
Results: Significant neutral marker differentiation was observed between varieties across sharp ecotones and both stable (elevation) and dynamic (successional) environmental gradients. Results indicate local adaptation of all varieties examined, including differential adaptation of the Hawaii Island-endemic variety to the high-light, high-mechanical-stress environment of rivers, differential growth, survivorship and anthocyanin production between seedlings of low- and high-elevation varieties under high uv light and temperature extremes, and the presence of the classic plant life history trade-off of fast growth in high light (early-successional variety) and high survivorship in shade (late-successional variety). A range of partial pre- and postzygotic isolating barriers was also observed among varieties with the strongest barriers seen in extreme-habitat specialists; however, little differential adaptation or isolation was observed within varieties.
Conclusions: Observations of Hawaii's dominant tree species suggest that significant adaptive differentiation and reproductive isolating barriers can arise over a few hundred thousand years within continuously distributed tree species spanning environmental gradients or ecotones. Further, the relatively slow evolution of reproductive barriers in trees and subsequent hybridization between young taxa (both intra- and interspecific) can lead to gross underestimation of adaptive differences between forms via neutral genetic markers. Given that hybridization among differentially adapted populations should facilitate the tracking of environments, taxa specialized on narrow, extreme habitats may be most at risk from climate change due to their stronger isolating barriers (and lower abundances). Lastly, plasticity appears to be limited in M. polymorpha, which may limit its response to climate change.

O57-12 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Local adaptation to microgeographic habitat patchiness in Amazonian trees: example of the hyperdominant Eperua falcata (Aubl.)

LOUISE BROUSSEAU[1], IVAN SCOTTI[2]
[1]INRA, UMR EcoFoG, 97310, Kourou, French Guiana
[2]INRA, UR FM, 84914, Avignon, France

Background: The evolutionary processes responsible for the maintenance of diversity in Amazonia are still poorly understood. The specialization of tree species to local conditions (hygromorphic bottomlands versus well-drained terra-firme on ferralitic soils) is supposed to have been driven by local adaptation, and suggests that microgeographic adaptive divergence would be a key evolutionary driver strongly involved in tree species diversification. However, this hypothesis had rarely been tested at intra-specific level (i.e. at a step before speciation, prior to reproductive isolation).
Methods: - A common garden in controlled conditions was set-up to measure the extent of genetically-driven phenotypic divergence for functional phenotypic traits between seedlings native of different local habitats (bottomlands, slopes and hilltops), and to test the hypothesis of local adaptation at phenotypic level.
- The hypothesis of adaptive divergence was further tested at both regional and local scales through the genome sequencing (Illumina HiSeq) of four populations' pools (two study sites, ~300 km apart, with two local habitats within each site, ~300 m apart). The data were assembled de novo to draw a reference genome and ~67,000 high-quality SNPs were detected. A hierarchical Bayesian model was developed to detect footprints of local adaptation at both regional and local scales.
Results:
- The common garden experiment revealed inherent variations in functional traits between populations for several traits including growth and leaf properties.
- The genome sequencing revealed consistent outliers for balancing and, more interestingly, for divergent selection (about 1% of the analyzed SNPs). Surprisingly, outliers for divergent selection were as abundant at local scale as at regional scale, in spite of the geographic distance considered (300 km versus 300 m) and extensive gene flow between local populations.
Conclusion: This study provides an original example of genetic divergence at microgeographic scale (in the order of hundreds of meters) in a hyperdominant Amazonian tree species. It is one of the first molecular evidence that microgeographic adaptation may drive genetic divergence in spite of extensive gene flow within wild and continuous populations. Such evidence of microgeographic adaptive divergence further reinforces the idea that local adaptation would be a key evolutionary process in Amazonia, probably involved in the maintenance of diversity.

O57-13 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Intra-specific variation in African tropical trees: molecular and phenotypic evidences

OLIVIER HARDY[1], JEAN-LOUIS DOUCET[2], KASSO DAÏNOU[1], JÉRÔME DUMINIL[3], ACHILLE BIWOLÉ[4], FÉLICIEN TOSSO[2]
[1]Université Libre de Bruxelles, Evolutionary Biology and Ecology, 1050, Brussels, Belgium
[2]Gembloux Agro-Bio Tech, University of Liège, Forest Resources Management, 5030, Gembloux, Belgium
[3]Bioversity Interational, -, 00054, Maccarese, Italy
[4]Université de Douala, Ecole Normale Supérieure d'Enseignement Technique, Douala, Cameroon

Background: The evolutionary and ecological importance of intra-specific variation has been little documented in tropical plants, in particular in Africa. However, new data has been obtained recently in African forest trees. Here we present some of the emerging patterns regarding the structure of intra-specific variation, mostly based on molecular genetic markers, but also on a few phenotypic based-studies.
Methods: Molecular markers (nuclear microsatellites, nuclear or plastid DNA sequences, SNPs,…) were used in 10 widespread forest tree species to describe their phylogeographic patterns and identify genetic clusters. We then applied climatic niche modeling approaches to test whether genetic clusters were significantly correlated with particular climatic conditions. Common garden experiments were performed on a few tree species to compare their growth performances according to their provenance origin.
Results: The large majority of species display two to five parapatric genetic clusters. Their origin could be explained by past population fragmentation. Testing their correlation with climatic variables is under way. Differences in growth performances according to the population of origin have been detected in tree species, even for populations belonging to the same genetic cluster.
Conclusion: Substantial molecular genetic variation is found within widespread African tree species and is typically structured geographically in the forms of a few genetic clusters. In some cases these clusters also differ by their climate niches, although it is currently not possible to test whether environmental factors were at the origin of their genetic divergence. Genetic differences between populations at traits potentially related to fitness also suggest that local adaptation could occur, even within genetic cluster.

O57-14 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Strong spatial genetic structure is correlated with climatic niche in a tree of the African tropical rain forest

RUMSAIS BLATRIX[1], JEAN PECCOUD[2], CELINE BORN[1], FINN PIATSCHECK[1], LAURE BENOIT[3], MATHIEU SAUVE[1], CHAMPLAIN DJIETO-LORDON[4], CHRISTIANE ATTEKE[5], JAN J. WIERINGA[6], DAVID J. HARRIS[7], DOYLE MCKEY[8]
[1]CNRS, CEFE, 34293, Montpellier, France
[2]Université de Poitiers, Ecologie et Biologie des Interactions, 86000, Poitiers, France
[3]CIRAD, CBGB, 34988, Montferrier-sur-Lez, France
[4]University of Yaounde 1, Laboratory of Zoology, POB812, Yaounde, Cameroon
[5]Université des Sciences et Techniques de Masuku, Département de Biologie, -, Franceville, Gabon
[6]Wageningen University, Biosystematics Group, 6708, Wageningen, the Netherlands
[7]Royal Botanic Garden Edinburgh, -, EH3 5NZ, Edinburgh, United Kingdom
[8]University of Montpellier, CEFE, 34293, Montpellier, France

Background: Pleistocene climatic oscillations led to range fluctuations in African rain forest organisms. Isolation of populations during the driest climatic phases resulted in genetic differentiation through mutation and drift. Recent re-expansion of the forest brought differentiated groups into secondary contact. We investigated whether past climate changes may have led to sufficient differentiation to trigger speciation in a central African rainforest tree, Barteria fistulosa (Passifloraceae).
Method: We genotyped 765 individuals of B. fistulosa at 12 microsatellite loci and characterized the spatial genetic structure by using Bayesian clustering algorithms, isolation-by-distance analyses and clines of synthetic alleles. We used species niche modelling (environmental and soil variables) to investigate ecological variables associated with genetic discontinuities.
Results: Trees showed a very steep genetic discontinuity between groups north and south of latitude 1°N. There was no evidence for effective gene flow between the two tree lineages in contact at the transition zone, despite the presence of a few hybrids. Niche modelling did not predict the occurrence of northern trees south of this genetic transition, and vice versa. The variable that contributed the most to niche differentiation was precipitation during the driest quarter of the year.
Discussion: The genetic discontinuity near latitude 1°N is inferred to be a tension zone resulting from reproductive incompatibilities between previously allopatric tree lineages. This tension zone may have stabilized at a climatic transition (between boreal and austral seasonal regimes), and matches patterns of genetic structure previously observed in other forest plant species of the region, suggesting that a tension zone may separate distinct lineages of several central African forest plants near the thermal equator. Our results suggest that northern and southern lineages could be locally adapted to climatic parameters, even for species with a continuous distribution in this area, and thus may respond differently to climate change. Understanding spatial genetic structure may thus help refine prediction of species distribution under future climate conditions.

O57-15 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Are tropical tree habitat specialists less variable in key functional traits than habitat generalists?

NATHAN KRAFT[1], IAN MCFADDEN[1], CLAIRE FORTUNEL[1], RENATO VALENCIA[2]
[1]University of California, Los Angeles, Department of Ecology and Evolutionary Biology, 90095, Los Angeles, United States
[2]Pontificia Universidad Católica del Ecuador, Laboratorio de Ecología de Plantas, Quito, Ecuador

Background: First principles suggest that habitat niche breadth within a species should be positively correlated with intraspecific variability or plasticity in traits related habitat use. We explored this prediction by examining intraspecific trait variation in tropical forest trees from the Yasuní forest dynamics plot in Eastern Ecuador, one of the most diverse forest communities on the planet. The plot is characterized by distinct topographic habitats formed by a ridge and valley system, and previous study has identified a number of taxa species that either specialize on ridge or valley habitat, or alternatively range across the topographic gradient. In particular, we predicted that topographic habitat generalists should display a great degree of trait variation within species than habitat specialists.
Methods: We compared variation in key functional traits sampled within the plot between three groups of species: ridge specialists, habitat specialists, and habitat generalists.
Results: Contrary to our expectations, we find little evidence that habitat generalization within the Yasuní plot is correlated with greater intraspecific variation in key functional traits.
Discussion: While broader habitat niche breadth is often associated with greater variability in key traits related to habitat use, we discuss alternative scenarios related to specialization that may result in the patterns that we have found in Yasuní.

O57-16 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

Intra-specific variation in functional traits between narrow endemic and widespread tropical trees

CHACON EDUARDO
University of Vienna, Division of Conservation Biology, Vegetation Ecology and Landscape Ecology, 1030, Vienna, Austria

The inter-specific variation (IV) of geographical range size (GRS) is still an open question. The ecological niche has a major role within hypotheses proposed to explain that variation. Although many ecological factors affect the species GRS, some studies support a correlation between the niche breadth and the GRS. In particular, IV in functional traits (FT) should be a close indicator of niche breadth. I studied the climatic niche breadth (CNB) and the IV of FT among narrow endemic and widespread tropical trees which are related phylogenetically.

In the tropical rainforest of the Southern of Costa Rica, I studied the IV in seven FT of 17 pairs of tree species. Each pair belonging to the same genus, one species of the pair has a narrow GRS and the other species has a larger GRS. I estimate the CNB using the localities of occurrences in the overall range and the climatic values extracted from Bioclim. I measured the CNB using as a parameter the climatic niche hypervolume. I described the IV of FT within individuals and between individuals and explored the relations with CNB.

The CNB explains the GRS (area of extension of occurrence) of the species ($R2=0.91$, $p<0.05$), also the latitudinal range of the geographical distribution ($R2=0.88$, $p<0.05$) and the elevational range ($R2=0.85$, $p<0.05$). For those FT as leaf area (LA), specific leaf area (SLA), leaf thickness (LT), leaf dry matter content (LDMC) which were measured in leaves, the IV within individuals was greater than between individuals. The IV of LA and SLA between individuals tends to be larger among widespread species than endemic species. The functional variability tends to be larger among widespread species, although some relations are not significant.

Endemic species studied had smaller CNB than widespread species in the same genus and there is a significant relationship between CNB and GRS size among all the species indistinctly of the genus. This result supports the previous hypothesis about the relationship between niche breadth and GRS as an ecological pattern. Besides, this result suggests that endemic species might be vulnerable to climate change and that in this group of species, the dispersal limitation has a little effect in the GRS. Although there is not a clear relationship between functional variability and CNB, the results suggest that IV of FT between individuals as well as functional variability could explain differences in CNB between some pairs of species in the same genus.

O57-17 – S57 *Intraspecific variation in tropical trees – implications for tropical forest responses to global change*
Thursday 23 June / 08:00-10:00 – Sully1

From Fragmentation Genetic to Genomics and Back

CHRIS KETTLE
ETH Zurich, Environmental System Science, 8092, Zurich, Switzerland

The Lowland forest of Borneo are dominated by a single family of large canopy and canopy emergent trees. These dipterocarp trees are among the most economically important tropical hardwoods in the world. Many of the species exhibit strong fine scale spatial genetic structure (FSGS). I will provide a summary of our recent work applying molecular approaches to better understand what drives patterns of intraspecific genetic diversity in dipterocarps. I will discuss the implications of this for management of forest genetic resources and restoration. Finally I present a new study which applies NGS and common garden studies to bring in a new era in Forest Fragmentation Genomics.

O58-01 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Projections of the future distributions of páramo and subalpine Neotropical forests from satellite image interpretation and climate data

EILEEN HELMER[1], L. SCOTT BAGGETT[2], BENJAMIN BIRD[2], CHRIS DALY[3], ELIZABETH GERSON[4], JOSEPH SMITH[3], THOMAS RUZYCKI[5], SHANNON VOGGESSER[5]
[1]USDA Forest Service, International Institute of Tropical Forestry, 00926, Río Piedras,PR, USA
[2]USDA Forest Service, Rocky Mountain Research Station, 80526, Fort Collins, CO, USA
[3]Oregon State University, Chemical, Biological & Environmental Engineering, 97331, Corvallis, OR, USA
[4]ERS/Springwood Ecology, 49931, Houghton, MI, USA
[5]Colorado State University, CEMML, 80523, Fort Collins, CO, USA

Background: The UN Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) is supporting global and regional reports and capacity building aimed at assessing biodiversity, ecosystem services, drivers of change in ecosystems and the present and projected future relationships among ecosystems, human health and well-being, and policy. Remotely sensed imagery from satellite or air borne sensors will be important to characterizing these relationships. We present an example of how new remote sensing products can help quantify the present and projected future extent of the tropical alpine ecosystem known as Páramo.
Methods: We mapped average number of frost days per year and annual average relative humidity for the Neotropics from hourly climate station data and existing climate maps and then compared these data to existing Landsat image composites for the region.
Results: We found that we could visually compare the Landsat imagery with maps of frost days to find regional thresholds in the average number of frost days per year that defined páramo and subalpine Neotropical forests, and that we could integrate our mapping model of frost days with future climate projections to predict changes in climate that define the extent of these ecosystems.
Discussion: Under some projected climate scenarios, we can expect that the extent of lands with the climate that currently supports páramo will decrease, and it will disappear in many places. Subalpine forest climate will expand in some places and disappear in others.

O58-02 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Mapping ecosystem services at the regional scale: the contribution of an up-scaling approach. The case of the Amazon pioneer front

SOLEN LE CLEC'H[1], VALÉRY GOND[2], GUILLAUME CORNU[2], THIBAUD DECAENS[3], SIMON DUFOUR[1], JOHAN OSZWALD[1], MICHEL GRIMALLDI[4]
[1]Université Européenne de Bretagne - Rennes 2, Laboratoire LETG Rennes – COSTEL (UMR CNRS 6554), 35000, Rennes, France
[2]CIRAD, BSEF, 34398, Montpellier, France
[3]Université Montpellier 2 Sciences et Techniques, Centre d'Écologie Fonctionnelle et Évolutive (CEFE), 34090, Montpellier, France
[4]Institut de Recherche pour le Développement (IRD), UMR 211 BIOEMCO, 93143, Bondy, France

Background: Large-scale ecosystem services (ES) mapping is a challenge for environmental management. A possible and low-cost method is the up-scaling approach, which we tested on Pará State, Brazil.
Method: We mapped four ES indicators (vegetation carbon stocks, rates of water infiltration into soil and a biodiversity and a chemical quality index) at the regional scale, from field and remote sensing data. To do so, we first classified the land cover from MODIS images. Then, we averaged the ES indicators (field data) per MODIS land cover class. Finally, we evaluated regional maps' accuracy through three different procedures: first, we mapped the variability of the ES indicators per land cover type. Secondly, we compared, statistically and visually, the regional ES indicators maps with local scale maps made from statistical models that linked remote sensing (Landsat and DEM Aster) and field (ES indicators) data. Finally, we calculated the correlations between our predicted values and independent datasets.
Results: Our results showed the spatial distribution of some ES indicators for Pará Sate. ES indicators providing is the highest in the forest, except the soil chemical quality index. Yet, Pará State, still mainly covered by forests, has known a large movement of deforestation from the east to the west, despite the creation of protected areas. The western part, marginally affected by deforestation, is thus characterized by high ES providing. On the contrary, the eastern part, severely damaged by deforestation, is associated with poor ES providing. Our results also showed the unequal capacity to get reliable ES maps at the regional scale. In other words, our results show the additional complexity of modeling ES whose variations are very partially based on land cover changes, such as the biodiversity index.
Discussion: Up-scaling approaches should bridge the gap between the spatial scales. These approaches complete large-scale maps by local knowledge and enable the estimation of the uncertainty of the maps and ES spatial representation at different spatial scales. They then may help to justify conservation actions by targeting the areas greatly damaged. Regional maps for other indicators of ES at the regional scale should be investigated. From this study, one could also decide to implement the proposed methodology to map ES indicators at a larger scale, even up to the global scale, if one possesses sampling data all over the world.

O58-03 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Characterizing texture- structure relationship in the tropical forests of Western Ghats of India using high resolution Cartosat Imagery

SOURABH PARGAL[1], PIERRE COUTERON[1], RAPHAEL PELISSIER[1], RAKESH FARARODA[2], GOPALAKRISHNAN RAJASHEKHAR[2], CHANDRA SHEKHAR JHA[2]
[1]Institut de Recherche pour le Développement (IRD), UMR AMAP (botAnique et Modélisation de l'Architecture des Plantes et des vegetations), 34398, Montpellier, France
[2]NRSC (National Remote Sensing Center), Forest and Ecology Division, 500625, Hyderabad, India

Context: Regional assessment of forest aboveground biomass (AGB) in tropical forests is spoilt by uncertainty. There is thus a major challenge in providing accurate carbon stock assessments especially in the context of REDD+ program. One of the major reasons for uncertainty in AGB estimates is the saturation of remote sensing signals at relatively low AGB values, for both optical reflectance and radar backscattering signatures. Canopy texture analysis of very high resolution (VHR) imagery have provided encouraging results for retrieving forest stand structure parameters for different tropical forests in Central Africa, French Guiana and India, with AGB values going above 650 Mg/ha. The method, Fourier Transform Texture Ordination (FOTO), performs well in characterizing texture-structure relationships and quantifying AGB variations, when tested for areas with a given forest type. However the robustness of such approaches across different forest types characterized by different forest structure and allometries, is more demanding and yet under investigation.
Method: In this study we focused on a gradient of tropical forest types, in the Western Ghats of India, ranging from dry deciduous to wet evergreen forests, in the Yellapur division, Uttara Kannada, Karnataka, India. Canopy texture analysis was done using the FOTO method in order to characterize the texture gradient present in the study area using Cartosat-1a imagery, a 2.5 m spatial resolution panchromatic sensor (500 to 850 nm) launched by Indian Space Research Organization (IRSO). We established 14 1-ha forest plots covering the whole gradient of canopy texture and forest types encountered in the study area and forest structural data was obtained. These 14 plots were used to calibrate texture - structure model for the forest types present in the area.
Result: Correlation between observed and predicted AGB was found to be good (R2 = 0.83) for nine plots lying in wet evergreen and moist deciduous zone which both displayed closed canopy, however the correlation dropped when four plots lying in fairly open canopy in dry deciduous or dry to moist transition zone were added to the analysis.
Conclusion: The FOTO method performed well in characterizing texture-structure relationships even with strong gradients present in the study area. However further investigations would be needed to test a larger gradient in forest types, such as including fairly open canopy forests in the dry deciduous region.

O58-04 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Understanding changes in the landscape based on a Landsat remote sensing analysis in the Karbi Anglong hills, Assam, India

TOBIAS SCHMID[1], SWEN BOS[1], JOHAN OSZWALD[2], VALERY GOND[3], CLAUDE GARICA[3]
[1]ETH Zürich, Environmental Sciences, 8092, Zürich, Switzerland
[2]Université de Rennes 2, COSTEL, 35043, Rennes, France
[3]CIRAD, ES, 34398, Montpellier, France

The landscape of the Karbi Anlong hills (State of Assam, India), south of the Kaziranga National Park, is shaped by small-scale farmers of the Karbi tribe. They traditionally practice jhum cultivation of upland rice and have started to cultivate cash crops such as bamboo, tea and rubber to improve their livelihoods. The forests of the Karbi Anglong hills also provide a crucial habitat for many flagship species, such as the Rhinoceros (Rhinoceros unicornis) and Tiger (Panthera tigris) during the monsoon months, while the Brahmaputra river floods the plains of Kaziranga.
Analyzing the historical changes in the landscape is a necessary first step to understand the forces driving land use and land cover change in the Karbi Anglong ecosystem. This information can then be used to identify practices, understand drivers and then design management interventions and policies, as part of an integrated landscape approach.
The forests of Karbi Anglong were analyzed through a GIS analysis of Landsat images from 1988 to 2016. Prior to classifying the forests, a succession and landscape dynamic model of this region was designed. Then a supervised classification was conducted throughout the northern Karbi Anglong hills to gain a full understanding of the forest structure and composition.
Human influence has shaped the landscape of the northern Karbi Anglong hills, whereas of lately an extensification was observed, which qualitative interviews attribute to political instability. This observation could be proven by the analysis of the Landsat (5&8) imagery as large proportions of young succession and immature forests were found throughout the study area. In addition fewer young yum fields were found within the study area.
Within this study we were able to establish a first result on landscape change that will serve as the foundation for future work in developing a landscape approach in the Karbi Anglong hills.

O58-05 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Analysis of the potential of 10m resolution optical imagery for the monitoring of logging impacts on the forest cover in the Republic of Congo

VERHEGGHEN ASTRID, EVA HUGH, ACHARD FRÉDÉRIC
European Commission, Joint Research Centre, Institute for Environment and Sustainability, 21027, Ispra, Italy

Background: Large areas of the African moist forests are being logged and little is known about the impacts on the forest and the related carbon emissions (Gourlet-Fleury et al. 2013). While logging roads can be persistent over time and captured in remote sensing derived products such as the Global Forest Cover Change (Hansen et al. 2013), the dynamic of associated openings in the canopy cover caused by skid paths, log decks and tree removal are not well documented due to temporal and spatial limitations of satellite images. The potential of the recently launched Sentinel-2a satellite to overcome those limitations and monitor small scale disturbances due to selective logging is investigated in this study.
Method: A unique time series of 10 m resolution satellite image is assembled from images acquired during the SPOT5-Take5 experiment complemented by the first Sentinel-2a acquisitions to monitor a certified selective logging concession in the Northern part of the Republic of Congo during the year 2015. Vegetation indices and a spectral un-mixing model are applied to the images in order to highlight gaps in the canopy. The satellite dataset is used to assess both the location and timing of logging activities by mapping the extent of canopy cover changes. The vegetation regeneration dynamics after logging events are assessed thanks to the high temporal frequency of image acquisitions.
Result and Discussion: Such imagery time series is suitable to monitor the temporal dynamics of logging roads and small disturbances in the forest cover related to wood extraction. We demonstrate that small openings in the forest canopy disappear in just a few months, underlining the requirement for high image acquisition frequency as provided by the Sentinel-2 mission. The resulting map of selective logged areas will be combined with field data to assess the area impacted on the ground. We will also investigate the possibility of linking such maps to measurements of wood extraction volume in the view of estimating changes in the Carbon stocks of logged forests over extended areas.
Additionally, the networks of logging roads will be analysed using a morphological spatial pattern software to compare the intensity of logging activities between this concession and a non-certified logging concession.

O58-06 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
Thursday 23 June / 10:30-12:00 – Sully1

Bioclimatic envelope models predict a decrease in tropical forest carbon stocks with climate change in Madagascar.

GHISLAIN VIEILLEDENT[1], OLIVER GARDI[2], CLOVIS GRINAND[3], CHRISTIAN BURREN[4], MAMITIANA ANDRIAMANJATO[5], CHRISTIAN CAMARA[6], CHARLIE J. GARDNER[7], LEAH GLASS[8], ANDRIAMBOLANTSOA RASOLOHERY[9], HARIFIDY RAKOTO RATSIMBA[10], VALÉRY GOND[11], JEAN-ROGER RAKOTOARIJAONA[12]
[1]JRC, Forest Resources and Climate, 21027, Ispra, Italy
[2]Bern University of Applied Sciences, HAFL, 3052, Zollikofen, Switzerland
[3]ETC Terra, ETC Lab, 5020, Paris, France
[4]WCS, Madagascar programme, 101, Antananarivo, Madagascar
[5]Ministère de l'Environnement et des Forêts, Direction Générale des Forêts, 101, Antananarivo, Madagascar
[6]Missouri Botanical Garden, Madagascar programme, 101, Antananarivo, Madagascar
[7]WWF, Madagascar and Western Indian Ocean Programme Office, 101, Antananarivo, Madagascar
[8]Blue Ventures, Blue Forests program, 101, Antananarivo, Madagascar
[9]Conservation International, Africa and Madagascar Field Division, 101, Antananarivo, Madagascar
[10]Université d'Antananarivo, Département des Eaux et Forêts, 101, Antananarivo, Madagascar
[11]Cirad, UPR BSEF, 101, Montpellier, France
[12]ONE, Direction des Informations Environnementales, 101, Antananarivo, Madagascar

Recent studies have underlined the importance of climatic variables in determining tree height and biomass in tropical forests. Nonetheless, the effects of climate on tropical forest carbon stocks remain uncertain. In particular, the application of process-based dynamic global vegetation models have led to contrasting conclusions regarding the potential impact of climate change on tropical forest carbon storage.
Using a correlative approach based on a bioclimatic envelope model and data from 1771 forest plots inventoried during the period 1996-2013 in Madagascar over a large climatic gradient, we show that temperature seasonality, annual precipitation and mean annual temperature are key variables in determining forest above-ground carbon density.
Taking into account the explicative climate variables, we obtained an accurate ($R2 = 70\%$ and $RMSE = 40$ Mg.ha-1) forest carbon map for Madagascar at 250 m resolution for the year 2010. This national map was more accurate than previously published global carbon maps ($R\ 2 < 26\%$ and $RMSE > 63$ Mg.ha-1).
Combining our model with the climatic projections for Madagascar from 7 IPCC CMIP5 global climate models following the RCP 8.5, we forecast an average forest carbon stock loss of 17% (range: 7-24%) by the year 2080. For comparison, a spatially homogeneous deforestation of 0.5% per year on the same period would lead to a loss of 30% of the forest carbon stock.
Our study shows that climate change is likely to induce a decrease of tropical forest carbon stocks. This loss could be due to a decrease in the average tree size and to shifts in tree species distribution, with the selection of small-statured species. In Madagascar, climate-induced carbon emissions might be, at least, of the same order of magnitude as emissions associated to anthropogenic deforestation.

O59-01 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Mapping intact and disturbed humid forests over the tropical belt from 32 years of Landsat time series

CHRISTELLE VANCUTSEM, FRÉDÉRIC ACHARD
Joint Research Center, European Commission, Forest Resources and Climate Unit, 21027, Ispra, Italy

Background: The need for quantitative and accurate information on the state and evolution of forest cover at regional and continental scales is widely recognized. Existing global land cover or forest cover maps derived from satellite imagery contain up-to-date and detailed thematic information but at coarse spatial resolution. Existing pan tropical Land cover maps at fine resolution (30m) do not separate evergreen forests from deciduous forests and do not consider temporal dynamics over long periods. A recent Global Tree Cover product at 30 m resolution (Hansen et al. 2013) includes (i) the tree cover percentage for year 2000 and (ii) tree cover changes between 2000 and 2014. This product is at fine spatial resolution but has a few limitations or drawbacks: (i) it does not contain thematic classes; (ii) the tree cover percentage alone does not relate to a forest definition and mixes forests with other land cover types (Tropek et al. 2014), (iii) no single continental tree cover threshold would allow discriminating forest areas (Achard et al. 2014).
Method: A pixel-based automatic methodology exploits the last 32-years of Landsat imagery to produce a pan-tropical map of dense humid forest cover at 30m resolution. Undisturbed forests and vegetation regrowths are delineated as well as recent deforestation and disturbance patterns. The long time series allows to separate the complex patterns of shifting cultivation or mosaics of crop and tree cover from pure forest cover. In addition, we characterize these later land cover classes by providing the timing and occurrence of the deforestation or disturbance events (date of first and last events, number of events).
Result and Discussion: The resulting forest map provides a much finer spatial resolution compared to existing global land cover products and delineates fine scale linear features such as gallery forests and small disturbance events like skid trails and logging decks. The use of a 32-year time series allows identifying most of the deforestation and degradation events that occurred during the last 3 decades and provides precise information of the date of the disturbances, which is of particular interest for assessing the present impacts of historical disturbances. The accuracy of the forest map is aimed to be assessed from an independent pan-tropical sample of reference data created through visual expert interpretation of fine resolution imagery.

O59-02 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

42 years of tree cover loss and gain in Southeast Sulawesi, Indonesia

MATTHEW POTTS, LISA KELLEY, SAMUEL EVANS
UC Berkeley, ESPM, 94720, Berkeley, USA

Understandings of contemporary forest cover loss are critical for policy but have come at the expense of long-term, multi-directional analyses of land cover change. Recent advancements within the field of land change science provide new opportunities to address this gap. This paper uses Landsat satellite data and Google Earth Engine to map land cover change in Southeast Sulawesi, Indonesia over a 42-year time period, 1972-2014. Our results demonstrate that forest cover loss constitutes the single largest net change over the period 1972-2014. However, gross rates of tree cover gain were three times higher than gross loss rates from 1972-1995 and equivalent to loss rates from 1995-2014. We argue that profound reconfigurations in land use, land access and land control throughout the Global South necessitate long-term histories of land cover change to inform richer social analyses; policy more attuned to the social and ecological realities of change in tropical landscapes; and more comprehensive assessments of biodiversity and carbon changes. Long-term analyses of change from elsewhere in the tropics are also likely to unearth other histories of extensive tree cover gain.

O59-03 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Carbon losses due to tropical forest fragmentation: a forgotten process in the global carbon cycle?

ANDREAS HUTH[1], KATHARINA BRINCK[2], RICO FISCHER[1], SEBASTIAN LEHMANN[1], JUERGEN GROENEVELD[1], SANDRO PUETZ[1]
[1]Helmholtz Centre for Environmental Research - UFZ, Ecological Modelling, 04229, Leipzig, Germany
[2]Imperial College, Centre of Complexity Science, SW7 2AZ, London, Great Britain

Tropical forests play an important role in the global carbon cycle. Thereby, deforestation is not only responsible for direct carbon emissions but also alters the forest structure and extends the forest edge area in which trees suffer increased mortality due to altered microclimatic conditions. Our aim is to quantify the global amount of anthropogenically created forest edge area and the resulting additional CO2-emissions by combining remote sensing data with previous empirical and modelling results.
We found that 1,106 million ha and thereby 10% of the global tropical forested area lies within the forest edge area and that 84% of this area is anthropogenically created. From this area, a total amount of 8 Gt C is emitted due to tropical forest fragmentation, which accounts for an annual loss of 0.25 Gt C equaling 17% of the annual carbon losses due to deforestation. Fragmentation in the tropics hence augments carbon loss from deforestation substantially and should be taken into account both when analyzing the role of vegetation in the global carbon balance and when adopting new management strategies in tropical forests.

O59-04 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Remote sensing indicators to monitor forest degradation trough time in the Brazilian Amazon

ISABELLE TRITSCH, LILIAN BLANC, VALERY GOND, CLÉMENT BOURGOIN, GUILLAUME CORNU, PLINIO SIST
CIRAD, UR 105 - B&SEF, 34398, Montpellier, France

Recently, several remote sensing methods have been developed to quantify the degradation of tropical forests. However, it still lacks finest spatial and temporal analysis to define trajectories of forest degradation i.e. a temporal analysis of the impacts on forest integrity. This communication aims to explore this issue and proposes a set of operational indicators to monitor forest degradation, which can constitutes a decision tool to support forestry managers and policy makers.
We studied the trajectories of forest degradation in the municipality of Paragominas – PA in the eastern Brazilian Amazon between 1995 and 2009, with a focus on the forestry company Cikel (400 000 ha certified by FSC since 2001).
First, we developed a semi-automatic remote sensing methodology to detect forest degradation using multi-temporal Landsat images (spatial resolution of 30m) covering the 1995-2009 period. This method included two steps: 1) Identification of logging tracks and log landings using an algorithm of Bourbier et al. (2013). This algorithm uses spectral indices and morphological filters to strengthen the spectral contrasts between bare soil and forest cover. 2) Identification of logging gaps - which are characterised by senescent vegetation due to trees fall - using a Spectral Mixture Analysis carried out in CLASlite (Asner et al., 2009) and a fraction index (Souza et al., 2013). So, we obtained annual maps identifying these three major impacts.
Secondly, we calculated annual landscape metrics of forest degradation using the R package «SpatialEco». Then, we calculated indicators which synthetize information about logging impacts and logging frequencies over the period from these annual degradation metrics. Finally, we selected a set of 6 indicators and statistically analysed the trajectories of degradation occurring in Paragominas using ACP and CAH.
Our results emphasize four major degradation trajectories from well managed forests to highly-logged forests. They clearly show a difference between legal and illegal logging in terms of forest degradation. Moreover, they indicate that impacts of FSC certification on forest degradation was positive. Degradation was statistically lower in the certified logged plots compared to the uncertified plots. These set of indicators are adequate to monitor forest degradation through space and provide guidance to policy-makers for a better management of forest resources.

O59-05 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Roadless space and logging in intact forest landscapes of the Congo Basin

FRITZ KLEINSCHROTH[1], SYLVIE GOURLET-FLEURY[1], JOHN HEALEY[2], FREDERIC MORTIER[1], PLINIO SIST[1], RADU STOICA[3]
[1]CIRAD, Environnements et Sociétés, 34398, Montpellier, France
[2]Bangor University, School of Environment, Natural Resources and Geography, LL57 2UW, Bangor, UK
[3]Universite Lille 1, Laboratoire Paul Painleve, 59655, Villeneuve d'Ascq, France

Background: Forest degradation in tropical regions is often associated with roads built for selective logging. Forest areas that are not accessible by roads are considered valuable because they provide habitat that is not immediately impacted by major human activities. The protection of such Intact Forest Landscapes (IFL) is high on the biodiversity conservation agenda, leading to a motion of the Forest Stewardship Council (FSC) to better protect IFL in certified forest concessions. However, in many parts of Central Africa logging takes place at very low intensities and most roads are abandoned after few years of timber harvesting. Taking limited road persistence into account we asked: How did road networks in FSC certified concessions affect IFL?
Methods: Intact forest landscapes can be conserved by retention of "roadless space", a concept based on distance to the nearest road from any point. We used the Empty-Space Function, a general statistical tool from stochastic geometry, to calculate roadless space based on time series of LANDSAT images. We followed the spatial and temporal dynamics of logging roads in a part of the Congo Basin that has recently seen rapid expansion of road networks for selective logging. We compared the development of roadless space in certified and non-certified logging concessions inside and outside areas declared as being IFL in the year 2000.
Results: The persistence of logging roads was limited over time, with only 12% of the overall network being permanently open. However, also taking only actively used roads into account, roadless space inside IFL has decreased rapidly due to expansion of logging into previously unlogged areas. Concessions that are now certified by FSC showed a slower rate of decrease before certification but after that their roadless space decreased to a level comparable to non-FSC concessions. The established concessions outside IFL showed a slight increase in roadless space due to forest recovery on abandoned roads.
Conclusions: We recommend that forest management should make the preservation of large connected forest areas a top priority by effectively monitoring - and limiting – the occupation of space by roads that are accessible at the same time. Given the strong dynamics in road detectability, we challenge the static definition of intact forest landscapes based on a buffer around any road ever detected. Instead we suggest the empty space function as a viable alternative to calculate roadless space.

O59-06 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Gold-rush in a forested El Dorado: long-term assessment of deforestation and policy issues

CAMILLE DEZÉCACHE[1], VALÉRY GOND[2], JEAN-MICHEL SALLES[3], BRUNO HÉRAULT[4]
[1]Université de Guyane, Sciences et Technologies, 97310, Kourou, French Guiana
[2]CIRAD, UPR BSEF, 34398, Montpellier, France
[3]CNRS, Lameta, 34060, Montpellier, France
[4]CIRAD, Environnements et sociétés, 97310, Kourou, French Guiana

Small-scale gold-mining has been the major driver of last decade deforestation within the Guiana Shield, one of the least degraded tropical forests in the world. Its social and environmental impacts are diverse and severe: water pollution due to turbidity and mercury, over-hunting in remote and preserved areas, insecurity, prostitution or malaria expansion. Deforestation is another direct effect of small-scale gold-mining, being also the easiest way of assessing its expansion.
Using deforestation maps produced by Hansen et al. (2013) and additional Landsat based dataset during the 90's, we provide a long term assessment of deforestation due to small-scale gold-mining between 1990 and 2014 in the Guiana Shield. Quasi-annual measurements of deforestation over the whole region show a very strong exponential relationship between deforestation due to small-scale gold-mining and gold-prices, explaining its massive increase until years 2012-13, when both prices and deforestation started to drop. This highly dynamic relationship suggests low level of governance at the regional scale and raises the question of the ability of local countries to efficiently limit their level of deforestation in eventual REDD+ like projects.
A focus on each country's situation shows very different temporal patterns of deforestation between French Guiana and both Suriname and Guyana. While deforestation in the two last countries follows gold prices from the beginning until the end of the period; small-scale gold-mining activity in French Guiana seems to be sharply increasing until 2004. Then, the pressure of military interventions against illegal mining, helped by a regular monitoring using remote sensing techniques (Mining Activity Observatory managed by the French Forest Service), probably overcomes the price effect.
Studying the efficiency of local policy in reducing deforestation and associated carbon emissions is of major importance to assess the ratio between economic costs and environmental benefits of such interventions. Looking at potential deforestation leakages between countries as a response to local management is also a necessity to improve environmental governance at the regional scale.

O59-07 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Putting No Deforestation into Practice - using the High Carbon Stock Approach to identify and conserve degraded tropical forests

ROSOMAN GRANT
HCS Approach Steering Group - C/O Helikonia Advisory Sdn Bhd, Suite 15-2a, Plaza See Hoy Chan Jalan Raja Chulan, 50200, Kuala Lumpur

Background: Deforestation in the humid tropics is contributing to a biodiversity, climate change and human livelihoods crisis. A key driver of this deforestation is the rapid industrial expansion of the palm oil, pulp and paper and rubber sectors. After many major global brands committed to 'No Deforestation', a methodology was needed to implement these commitments - the High Carbon Stock (HCS) Approach.
Method: The HCS Approach is a science-based but practical land use planning methodology that identifies forest areas for conservation and degraded lands that may be suitable for development. After over 60 assessments with palm oil, pulp and paper and rubber industrial sectors in four countries in Asia and Africa, over millions of hectares, experience with the implementation of the HCS Approach will be presented. Key elements of the methodology are: remote sensing information combined with field biomass plots to stratify vegetation, biodiversity conservation science principles to analyse identified forest patches and make recommendations for conservation, integration with community rights via participatory mapping and Free Prior and Informed Consent (FPIC), integration with High Conservation Value areas and with peatland and riparian areas, adaptation for smallholders, and innovations to achieve the long-term conservation and restoration of the HCS forest areas in the landscape.
Results: Results will be presented from 4 years of trials, pilots and large-scale implementation. The methodology is adaptive and still evolving to address a range of situations in the tropics.
Discussion/Conclusion: Key lessons learned and current challenges will be presented, with a focus on the applied use of remote sensing data, and the integration of remote sensing technical data with bottom-up social requirements and field data. The HCS Approach has been found to be a successful methodology to identify forest areas for conservation and restoration, and be an integrative conservation and land use planning tool within complex social settings.
The presentation will be made on behalf of the HCS Approach Steering Group - a multi-stakerholder initiative including companies, NGOs, and technical support organisations. See www.highcarbonstock.org
Key words: Deforestation, High Carbon Stock, forests, degraded lands, biodiversity, carbon, conservation, FPIC, smallholders

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O59-08 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
Thursday 23 June / 14:30-17:00 – Sully1

Application of remote sensing and GIS for multi-temporal assessment of forest coverage change detection and carbon sequestration: Case of Nyungwe national park, Rwanda

EVARISTE RUTEBUKA[1], SHILIANG LIU[1], JINYAN ZHAN[1], ZHANG LIXIAO[1], APPOLINAIRE WILLIAM[2]
[1]Beijing Normal University, School of Environment, +86, Beijing, China
[2]Regional Network for Conservation Educators in the Albertine Rift, +250, Huye, Rwanda

Protected areas (PA), especially montane forests, have been identified as an essential tool for conserving biodiversity and as key sources of ecosystem services, which include Net Primary Productivity (NPP), carbon sequestration, habitat and shelter for endemic and endangered species, and clean water. The Rwandan protected areas are the most fragile and still threatened by human activities due to high population density and high poverty rate. Presented in this paper is a multi-temporal canopy cover and carbon sequestration assessment of the Nyungwe montane rainforest, known to be one of the six key landscapes identified for conservation in the Albertine Rift using remote sensing and GIS techniques combined with a light use efficiency model.
The indicators of daily canopy, Net Primary Productivity and carbon sequestered from 1986 to 2010 were investigated. The results showed that forestland NDVI average mean has a continuous decline from 0.45 to 0.29 and pixel based NDVI change detection showed that 92.4% of forestland has undergone degradation, despite the great conservation effort from WCS, Government and NGOs. The entire park has lost approximately 38% of its daily NPP and carbon sequestration capacity. Its wetland has faced a continuous degradation too.
The study revealed that the degradation was evenly distributed across the entire area of the park, which negatively affects endemics and endangered species of this park through lack of alternative habitat once one habitat becomes less suitable. Climatic and topographic factors are not much related to this degradation while the most suspected factors behind this degradation are anthropogenic activities particularly the country insecurity which ended up by the 1994 Genocide. This study provided the clear message to the Nyungwe manager and government about the over-time perennial degradation. Thus, much effort and pragmatic strategy still needed to cope with this degradation.

O60-Introduction – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

The role of soil characteristics on forest structure and dynamics in extremely poor tropical soils

STEPHAN A. PIETSCH
IIASA/ESM – International Institute of Applied Systems Analysis / Ecosystems Services and Management Program, Schlossplatz 1, 2361 - Laxenburg, Austria

Tropical ecosystems in general and tropical forests in particular reembleone of the major factors in the global carbon cycl. Yet, rising atmospheric CO2 concentrations, increasing nitrogen deposition and constant to decreasing supplies of other nutrients are likely to alter tropical ecosystems in an unprecedented way. An ever increasing proportion of the tropics face direct anthropogenic impacts, be it by intensified grazing, increasing forest exploitation for timber and NTFPs, « sustainable » forest management or land conversion for temporal or permanant agricultural use. Changes in species composition and probable biodiversity loss will feedback on the functional composition and the carbon sequestration potential.
A comprensive view on tropical ecosystems needs field studies on reference ecosystems, experiments on and monitoring of management impacts in order to understand the consequences of anthropogenic influence. For assessing the global and long term impact of these changes modelling is an essential tool since it translates the identified underlying mechanisms into a framework of changing ecosystem functioning.
This becomes even more important when considering that ecosystem behavior is goverened by a multitude of nonlinearities, exhibits hysteres effects or even may develop sensitive dependence on initial conditions, i.e. become chaotic.

O60-01 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

The role of soil characteristics on forest structure and dynamics in extremely poor tropical soils

ORIOL GRAU[1], BRUNO HÉRAULT[2], BRUNO FERRY[3], VINCENT FREYCON[4], MATHILDE DESPREZ[5], LILIAN BLANC[6], CHRISTOPHER BARALOTO[7], JÉROME CHAVE[8], LAURENT DESCROIX[9], AURÉLIE DOURDAIN[10], STÉPHANE GUITET[11], IVAN JANSSENS[12], JORDI SARDANS[13], JOSEP PEÑUELAS[14]
[1]CREAF-CSIC, Global Ecology Unit, 08193, Bellaterra, Spain
[2]CIRAD, UMR Ecologie des Forêts de Guyane, 97387, Kourou, France
[3]AgroParisTech, ENGREF, UMR, 54000, Nancy, France
[4]CIRAD, UR Dynamique forestière, 34398, Montpellier, France
[5]CIRAD, UMR Ecologie des Forêts de Guyane, 97387, Kourou, France
[6]CIRAD, BSEF, 34398, Montpellier, France
[7]International Center for Tropical Botany (ICTB), Department of Biological Sciences Florida International University, 11200, Miami, USA
[8]CNRS, Laboratoire Evolution et Diversité Biologique, 31062, Toulouse, France
[9]ONF- Guyane, Réserve de Montabo, 97307, Cayenne, France
[10]CIRAD, UMR Ecologie des Forêts de Guyane, 97387, Kourou, France
[11] INRA-ONF, UMR Amap, 34398, Montpellier, France
[12]University of Antwerp, Department of Biology, 2610, Wilrijk, Belgium
[13]CREAF-CSIC, Global Ecology Unit, 08193, Bellaterra, Spain
[14]CREAF-CSIC, Global Ecology Unit, 08193, Bellaterra, Spain

Background: Tropical forests stock large amounts of biomass and play a key role on the global C balance. But tropical forest productivity is expected to be nutrient-limited because tropical forests generally grow on substrates with low nutrient content. However, the role of soil characteristics in the interplay of tropical forest structure and dynamics is yet poorly studied. We investigated if soil characteristics can be used: 1) to predict forest structure (tree diameter, stem density, above-ground biomass) and dynamics (growth rate, mortality rate, above-ground productivity) and 2) to explain the interplay between forest structure and dynamics in an exceptionally nutrient-poor region.
Method: We used permanent forest plots data on more than 34.000 trees to link forest structure and dynamics to soil characteristics (nutrient content, texture and litter quality) across 9 sites in French Guiana.
Results: Quadratic diameter, biomass, growth rate, mortality rate and productivity did not co-vary with site-level changes in soil nutrient availability. Nutrient content in litter co-varied positively with quadratic diameter. Growth rate was negatively correlated with stem density and biomass; mortality rate was positively correlated with growth rate but negatively correlated with biomass.
Discussion: Soil nutrient availability per se is probably not the main driver of forest structure and dynamics in these exceptionally nutrient-limited soils in French Guiana. The lack of sensitivity to site-level changes in soil fertility suggests that alternative nutrient-driven mechanisms other than the direct absorption of nutrients from soil, such as the uptake of nutrients from litter or nutrient resorption during leaf senescence may control forest structure and dynamics, together with other abiotic factors such as water availability. The role of soil characteristics on forest structure variables possibly has an indirect effect on forest dynamics. We hypothesise that the large accumulation of biomass is a crucial strategy to accumulate nutrients and reduce the dependency on soil nutrient availability. Ecosystem-level strategies and adaptations to extremely low soil nutrient availability combined with the long-term low disturbance regimes in French Guiana may help explain the low productivity and the high accumulation of biomass compared to more fertile tropical forests.

O60-02 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

Nutrient uptake, resorption and allocation along a disturbance gradient in Bornean tropical forests

TAKESHI INAGAWA[1], TERHI RIUTTA[1], LIP KHOON KHO[1], YADVINDER MALHI[1], NOREEN MAJALAP-LEE[2]
[1]University of Oxford, School of Geography and the Environment, OX1 3QY, Oxford, United Kingdom
[2]Forest Research Centre, Sabah Forestry Department, 1407, Sandakan, Malaysia

Tropical forests are frequently regarded to be nutrient limited, either by phosphorus (P), nitrogen (N) or possibly by particular macronutrients (K, Ca and Mg). However, there have been very few direct studies of nutrient uptake in tropical forests, because such studies need not only the measurement of nutrient stoichiometry but also net primary productivity (NPP), which requires frequent and longterm monitoring.
We estimated nutrient uptake partitioned into tree components as well as nutrient resorption by green leaves along a disturbance gradient in Malaysian Borneo (within the Stability of Altered Forest Ecosystems Project and Lambir Hills National Park). In addition, we measured nutrient allocation to woody components in 14 different locations within a whole tree as well as the trunk and branch wood density. In total, 915 tree components of 165 trees (species n = 41) from 9 study plots were sampled and chemically analysed for N, P, K, Ca, Mg and C concentrations.
In contrast to NPP, which was dominated by woody productivity, nutrient uptake was driven mainly by the canopy, which accounted for 4964% depending on the nutrient. The mean contribution of resorption to nutrient uptake was as high as 36.3% (N), 48.2% (P), 48.2% (K), and 18.7% (Mg) respectively. The resorption rate was substantially higher in old growth plots than in logged plots. Soil fertility strongly correlated with P uptake, but not with other nutrient uptake. A plot on sandy soil showed much smaller Ca uptake than a neighbouring plot on clay soil.
Green leaf P concentration was a strong predictor for branch and fine root P concentration. Among woody components, nutrient concentrations in the bark were substantially high: the bark to trunk heartwood ratio was 2.9-13.7 to 1 depending on the nutrient. Between the trunk heartwood and sapwood, there was no significant difference. Dipterocarp species, however, had extraordinary variation in nutrient allocation both within the trunk cross-section and along the length of the tree.
In summary, we were able to calculate detailed nutrient budgets for a variety of tropical forests along a disturbance gradient, which could inform management practices. While there was substantial interspecific variation, some broad trends and patterns in nutrient uptake and allocation emerged.

O60-03 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

Long-term recovery dynamics in a natural regeneration forest

FRANZISKA SCHIER[1], STEPHAN A. PIETSCH[2]
[1]Thünen Institute, Institute of International Forestry and Forest Economics, 21031, Hamburg, Germany
[2]IIASA, Ecosystems Services and Management, 2361, Laxenburg, Austria

The long-term implications of over-exploitation and degradation in the tropics are less well known than those of deforestation. Yet, robust information on the lasting impact of degradation on forest characteristics and tree species diversity as well as their recovery potential are essential.
This case study focuses on the coastal rainforest of the Mondah peninsular (Gabon). The forest was frequently exploited for more than 200 years and put under conservation in 1971. Recovery of the forest was assessed by forest inventories performed in 1993 and 2011. Replicate analysis revealed that for trees with dbh≥10cm, the mean tree diameter, height, basal area as well as the above-ground biomass and carbon were significantly higher in 2011. On the stand level, 12 % less stems were counted in 2011 while the stand basal area, above-ground biomass and carbon were 31%, 41% and 40% higher. The thickening and heightening of the forest stand resulted in a shift in the stem diameter and height distribution, respectively: In 2014, less trees were found with a dbh<30cm while more trees were observed in the higher diameter classes up to 60cm dbh. In 1993, the vertical stratification of the forest comprised 66%, 28% and 6 % trees in the understory, medium, and canopy layer, respectively. In 2011, only 55% of the trees stuck in the understory, while 36% and 9% of the trees reach the medium and canopy layer, respectively. In 2011, 868 stems dbh≥10cm were represented by 94 tree species, while in 1993 the ratio was 85 species to 779 trees with dbh≥10cm. Abundance and dominance of the most important tree-species also changed between 1993 and 2011, e.g. the early pioneer tree Musanga cecropioides - most abundant in 1993 - was no longer found in the dense forest, while the long-lived pioneer Aucoumea klaineana became most abundant in 2011. Additional results referring to trees with a dbh< 10cm as well as a more detailed analysis of tree-species diversity will be provided in the session.
Literature references were used to benchmark the present state of the forest and confirm the high regeneration potential of degraded coastal forests in Gabon.

O60-04 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

Biodiversity effects on forest functioning across spatial and temporal scales

MASHA VAN DER SANDE[1], LOURENS POORTER[1], MARIELOS PEÑA-CLAROS[1], ERIC ARETS[2]
[1]Wageningen University, Forest Ecology and Forest Management, 6708NS, Wageningen, the Netherlands
[2]Alterra, Vegetation, Forest and Landscape ecology, 6708NS, Wageningen, the Netherlands

Tropical forests store 25% of the terrestrial carbon and produce 34% of the gross primary productivity, which makes them crucially important in mitigating climate change. Furthermore, tropical forests are hyper-diverse, hosting around 47,000 tree species. The niche complementarity theory predicts that this high species diversity increases the efficiency of resource acquisition and use, and that it would therefore increase ecosystem process rates. Additionally, the insurance theory predicts that high species diversity leads to long-term insurance of ecosystem processes against environmental changes. On the other hand, the mass-ratio theory predicts that the traits of the most dominant species determine ecosystem processes. We know, however, very little of how biodiversity attributes (such as species diversity and community-mean traits) determine biomass dynamics in tropical forests. This information is important to understand the climate change mitigation potential of tropical forests. In this presentation, I will explore how biodiversity attributes and environmental conditions determine biomass stocks and dynamics at various spatial scales (local vs. continental) and temporal scales (decades vs. centuries). I will do so by highlighting results from several of our studies that together may provide a more complete picture of biodiversity effects on ecosystem processes in tropical forests.

O60-05 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

Changing coffee agroforestry in the Western Ghats: loss of biodiversity and ecosystem services through intensification in Kodagu, South India

MAIKE NESPER[1], JABOURY GHAZOUL[1], CHRISTOPH KUEFFER[2]
[1]ETH Zurich, USYS -ITES, 8092, Zurich, Switzerland
[2]ETH Zurich, USYS-IBZ, 8092, Zurich, Switzerland

Kodagu in the Western Ghats is India's main coffee growing region. In this biodiversity hotspot, coffee is traditionally grown in very diverse agroforestry systems. In the past 40 years, coffee agroforestry has been expanding and intensified. Intensification happens at the level of the shade tree canopy (reduction in native tree diversity and planting of exotic timber tree Grevillea robusta [Proteaceae]) and the soil management system (conversion from organic [manure and compost] to conventional NPK-fertilization). While it is hoped that intensification leads to economic benefits, resulting biodiversity loss and effects of different nutrient regimes on soils and coffee productivity and quality are not well understood.
We conducted an on-farm study to investigate the effect of different shade tree compositions and fertilization treatments on coffee plant performance. It was hypothesized that shade tree diversity reduction affects biodiversity and multiple ecosystem services negatively, with conversion from organic to conventional soil management further aggravating these negative effects. Loss of ecosystem services is expected to counteract benefits of intensification. We selected 25 farms classified into three types: i) organic and native, multispecies shade tree canopy (9 replicates), ii) conventional and native, multispecies shade tree canopy (9), and iii) conventional and Grevillea robusta shade tree canopy (7).
As a result of a conversion from native-multispecies to Grevillea shade trees not only the native trees were replaced by Grevillea trees but among the remnant native trees diversity and number of red-listed species was additionally reduced. Ecosystem structure changed from few old trees in native-multispecies to many young trees in Grevillea plantations. Diversity loss led to a reduced and altered nutrient input through shade tree litter. Conversion from organic to conventional reduced the pH, soil organic matter and cation exchange capacity while fertilization didn't improve leaf nutrient deficiencies. Coffee productivity wasn't affected by shade tree cover or fertilization treatment but coffee plants in Grevillea plantations produced more single-seeded berries, and coffee beans suffered from higher coffee borer beetle (Hypothenemus hampei) attacks. In summary while we did not find substantial yield increase through intensification, several ecosystem qualities were negatively affect: tree biodiversity, soil quality, and resistance to pests.

O60-06 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
Thursday 23 June / 08:00-10:00 – Sully3

Historic carbon the GHG balances of tropical grassland from 1901 to 2010

JINFENG CHANG[1], PHILIPPE CIAIS[2], NICOLAS VIOVY[2], THOMAS GASSER[2]
[1]Sorbonne Universites (UPMC, Univ Paris 06), LOCEAN-IPSL, 75005, Paris, France
[2]LSCE, UMR8212, CEA-CNRS-UVSQ, 91191, Gif-sur-Yvette, France

The greenhouse gas (GHG) balance of tropical grasslands, including CO2, CH4 and N2O, is estimated using the new process-based biogeochemical model ORCHIDEE-GM (Chang et al., 2013; 2015) at a resolution of 0.5° by 0.5° over the period 1901–2010. The simulation takes into account: (1) a mechanistic representation of grassland management including grazing and mowing; (2) the history of grassland management reconstructed by combining livestock production information and modelled grassland productivity (Chang et al., 2016); (3) the history of nitrogen fertilization and deposition; (4) land-use change; (5) variable CO2 and climate. Tropical grassland acts as the GHG source from 1901 to 2010. The decadal GHG balances varied between 120 to 273 Tg CO2-C equivalent per year, while the inter-decadal variation resulted from CO2 fluxes (i.e., net biome productivity, NBP). Since 1960s a CO2 sink over tropical grassland is simulated except for 1990s. On the other side, rapid increase in domestic livestock numbers over tropical region offset the grassland CO2 sink and turns it into an increasing GHG source. The modelled tropical grassland GHG balances also show regional difference in spatial pattern and time evolution, which could be attributed to climate change, management history, and land-use change.

O61-01 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully3

Introduction - Biodiversity impact is not biodiversity conflict

SOPHIE CALMÉ[1], REHEMA WHITE[2], LOU LÉCUYER[1]
[1]Université de Sherbrooke, Department of Biology, J1K 2R1, Sherbrooke, Quebec
[2]University of St Andrews, Department of Geography and Sustainable Development, KY16 9AL, St Andrews, Scotland

The ever increasing encroachment on natural ecosystems, especially in the tropics, is likely to keep interactions between humans and biodiversity also on the rise. Such interactions may lead to biodiversity conflicts when objectives over biodiversity differ and interested parties compete over some aspect of it, while pursuing their interests at each other's expense. Biodiversity conflicts epitomise failed sustainable development, through environmental degradation and lack of social justice. Traditionally, biologists have approached biodiversity conflicts under the environmental integrity component of sustainable development, aiming to reduce conflicts through the reduction of impacts (i.e., the negative interactions between humans and biodiversity). However, the implementation of strategies aiming to reduce impacts (e.g., fences to keep predators off) has rarely led to long-term conflict resolution. This suggests that the underlying human-human conflicts play a major role in biodiversity conflicts. Also, while impact management can be achieved through the creation of tools (e.g. fences) or legislation (e.g. compensation programs), biodiversity conflict management requires an approach involving how to reconcile different points of view and is consequently more challenging. The resolution of biodiversity conflicts, therefore, hinges upon a higher understanding of the socio-economic and political context of conflicts, and cannot be limited to reducing biodiversity impact. The social aspects exerting influence over such conflicts are, for instance, the perception of power balance between actors, and their values and beliefs related to biodiversity. The latter can inform managers about the degree of concordance among people regarding the environment, but does not address people's relationships regarding environmental management. The former relates to how actors perceive and give particular attributes to other actors' behaviour regarding resource management. How people perceive each other may explain the lack of trust or resentment that can sap any effort of conflict resolution. Building trust between resource users and natural resource managers is therefore considered essential in order to gain support of local community for conservation policies.

O61-02 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully3

Poisoned birds and four slashed tires: Building capacity to manage biodiversity conflict in South America

JONATHAN DAIN[1], NATALIE COOPER[2], DENYSE MELLO[3], MAURICIO NUNEZ-REGUEIRO[4]
[1]University of Florida, Tropical Conservation and Development Program, Center for Latin American Studiesr, 32611, Gainesville, FL, USA
[2]University of Florida, School of Forest Resources and Consservation, 32611, Gainesville, FL, USA
[3]University of Florida, Tropical Conservation Leadership Initiative, Center for Latin American Studies, 32611, Gainesville, FL, USA
[4]University of Florida, Wildlife Ecology and Conservation, 32611, Gainesville, FL, USA

Background: The world currently has 7.3 million people. Projections suggest 8.5 billion by 2030 and 9.7 billion by 2050 (United Nations 2015). Increasing population places great pressure on biological systems. It also intensifies pressure on social relationships as greater numbers of people negotiate the use and management of the natural resources they depend on. Biologists and other conservation professionals in Latin America increasingly find themselves enmeshed in complex natural resource and biodiversity conflicts they have not been trained to handle. Working effectively with diverse and often competing sets of actors with varying levels of power requires a specialized set of concepts, skills and strategies for building trust and promoting collaborative problem solving. In this presentation, the authors describe one approach to helping biologists and other conservation professionals develop conflict management skills.
Method: In 2014 and 2015 respectively, conflict management courses were developed for the Instituto Nacional de Tecnologia Agropecuaria research station in Entre Rios, Argentina and WWF Brazil in Acre, Brazil. The two cases illustrate an innovative model for capacity building. In Entre Rios, the expansion of soy production has created conflict between famers and biologists over bird conservation. In the Chico Mendes Extractive Reserve western Amazonia, a sustainable timber management project has led to distrust and tension between reserve dwellers and those associated with the project's design and management. Fifty-five people were trained in the two courses, both of which were developed in close collaboration with local institutions and current and former graduate students of the University of Florida's Tropical Conservation and Development Program. Course participants applied frameworks for analyzing sources of conflict, interacted with local context experts, visited areas where tensions were manifest and had on-site conversations with stakeholders on different sides of issues. The role of values and perceptions in shaping behavior was emphasized and participants practiced conflict management skills including listening, framing, meeting design, multiple-interest negotiation and mediation.
Results: Post-course evaluations and later follow-up indicate positive impact on the ability of participants to listen to and understand competing interest groups, organize effective meetings and negotiate challenging issues.

O61-03 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully3

Why might actors perceive environmental management as being unfair? Understanding constructions of justice appraisal in the case of jaguar management in Calakmul, Mexico

MARIE-LOU LECUYER[1], SOPHIE CALMÉ[1], REHEMA WHITE[2], BIRGIT SCHMOOK[3], VIOLAINE LEMAY[4]
[1]Université de Sherbrooke, Biologie, J1K 2R1, Sherbrooke, Canada
[2]Universit of St Andrews, Geography & Sustainable Development, KY16 9AJ, St Andrews, UK
[3]El Colegio de la Frontera Sur, Conservation andBiology, 77014, Chetumal, Mexico
[4]Université de Montréal, Droit, H3C 3J7, Montréal, Canada

Biodiversity conflicts centered on human-wildlife interactions have usually been addressed with regards to the impacts of animals on human beings or properties and, conversely, of humans on animals, with the ultimate goal of reducing those impacts. However, this has rarely lead to long term conflict resolution, which suggests that conflict management should consider more than the material aspects of damages and should focus on underlying human-human conflict. Through the case study of a biodiversity conflict occurring around human-jaguar coexistence in the Calakmul region, Mexico, our research explores actors' feelings of injustice. Our interest does not lie in an objective representation of justice as defining right or wrong, but instead, in the perception and subjectivity of justice appraisal by individuals regarding wildlife management. We further divide justice between procedural environmental justice (i.e. fairness in the process of decision-making), distributive environmental justice (i.e. fairness in the actual distribution of environmental burden), and ecological justice, which represents a concern for the intrinsic value of the environment and the "right to live" of species. During focus groups using different scenarios of natural resource management with livestock breeders on one side and crop producers on the other side, we investigated how people assess justice and the criteria they use. The use of scenarios during focus groups allowed insight to be gained into the variability of justice appraisal. Our results show that criteria such as a lack of trust in decision makers or failure to represent all actors in the decision making process might trigger biodiversity conflicts. Furthermore, crop producers seemed to give more importance to ecological justice (e.g. the right of jaguar to exist) than livestock breeders. Those results support the view that focussing only on reducing jaguar impact on livestock is not sufficient to reduce the conflict, and that subjective justice is one of the important social factors to be included in more integrative approaches to managing biodiversity conflict. Ultimately, this research aims to improve human-human relationships to enhance the management of biodiversity conflicts in a way that can reduce biodiversity impacts, resulting in better conservation outcomes for wildlife.

O61-04 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully3

Conservation conflict transformation in action: addressing conflict dynamics affecting the endangered Grevy's zebra in Kenya

LYNN KIMMEL
Antioch University New England, Environmental Studies, 03431, Keene, USA

Background: Without peace, conservation action cannot succeed. In the fertile plains of El Barta, violent livestock raiding between local communities over cattle, natural resources and land rights, combined with the absence of state security, has imperiled the local population of endangered Grevy's zebra (Equus grevyi), whose habitat lies directly in the conflict zone. Intractable inter-ethnic conflict has made it difficult for the Grevy's Zebra Trust (GZT) to meet critical conservation goals necessary to protect this endangered species. GZT recognizes that contributing to community peacekeeping efforts could support sustainable conservation. To address human-wildlife conflict and peacebuilding challenges, GZT implemented, at a grassroots level, the transdisciplinary framework of Conservation Conflict Transformation (CCT) to strengthen its community conservation work and provide a foundation for peaceful coexistence.
Method: I developed an approach that integrates the CCT platform (Human Wildlife Conflict Collaboration) with peacebuilding and experiential learning methodologies, including stakeholder interviews, conflict mapping, direct observations, and customized CCT experiential workshops with evaluation, to cultivate mutual understanding towards achievement of local conservation objectives.
Result: My analysis found that CCT theory and practice has application across multiple conservation disciplines, from managerial to field level. Planning and investing in the appropriate CCT strategy and implementation, including relevant skill-building workshops, has important implications for developing conservationists' capacity to understand conflict dynamics and the human relationships that drive conflict. By engaging in an active conciliation process, conservationists can achieve greater compatibility between actors and develop more workable and sustainable outcomes for conservation.
Conclusion: Applying CCT to conservation conflicts can offer new opportunities to build and strengthen relationships between multiple stakeholders and parties in conflict, effectively facilitating the development of innovative, constructive, and collaborative strategies to address social conflicts that are the root of biodiversity conflicts. Moreover, conservation interventions framed within the conflict transformation model could be an important new paradigm for peacebuilding and development, enabling parties in conflict to build shared vision and identities through conservation.

O61-05 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully3

Biology is (almost) irrelevant. Governance is (almost) everything for successful biodiversity conservation outcomes in Africa

MICHAEL MUSGRAVE
University of St Andrews, Geography & Sustainable Development, KY16 9AL, St Andrews, United Kingdom

Much of the biological knowledge we need to conserve dry, deciduous tropical forests is in place. There remain important questions to be answered around the role of fire and phenological responses to environmental factors. Scale based sampling issues remain problematic for forest enumeration. However, the overwhelming factor in determining whether these forests can be conserved involves the relationship between the people who use the forests and the authorities who claim the right to govern their usage. In Africa the failure to devolve economic and administrative power to local levels, the conflicting claims of traditional and state authorities and the problem of widespread corruption should occupy researchers more than biological studies if the aim of these studies is to facilitate biodiversity conservation.

O61-06 – S61 *Managing habitats and species or managing people? The challenges and opportunities of biodiversity conflicts in sustainable natural resource management in the tropics*
Thursday 23 June / 10:30-12:00 – Sully

What is the role of biologists in biodiversity conflicts? An interactive debate exploring routes to sustainability

REHEMA WHITE[1], SOPHIE CALMÉ[2], MARIE-LOU LECUYER[2]
[1]University of St Andrews, Department of Geography and Sustainable Development, KY16 9AL, St Andrews, Scotland, UK
[2]Université de Sherbrooke, Département de biologie, J1K 2R1, Sherbrooke, Canada

The roles of academics have traditionally been research, teaching and engagement. However, in normative disciplines such as conservation biology, there is an imperative to do more than produce and disseminate knowledge. In tropical regions, biologists seeking to conserve biodiversity often work with indigenous peoples, NGOs and government departments. In many cases different actors seek different outcomes with relation to biodiversity management, and they may act against each other's interests, initiating biodiversity conflicts. Successful management of biodiversity conflicts requires human-human interactions to achieve sustainability goals. Recognising what is required, the aim of this session is to explore the roles of biologists in biodiversity conflicts and debate the fuzzy boundaries between academia, advocacy and activism.
This session explores possible routes for biologists to engage in biodiversity conflict management by drawing on literature, the previous studies and audience experiences. The use of clickers will enable us to capture and immediately share the views of participants in this session, developing a debate using both quantitative and qualitative methods. Firstly, we explore if there is a clash between roles in theory and roles in practice; how many biologists have been asked/expected to go beyond information provision and what forms of dilemma have presented themselves? Secondly, we examine how these situations have been or could be addressed. Tactics may include collaboration with others, such as social scientists or NGOs, or personal development of facilitation skills. We investigate the potential for individuals to specialise or generalise. Thirdly, we debate the extent to which tropical conservation biology represents a modern post-science activity in which the lines between knowledge production, knowledge exchange and implementation have become blurred. We discuss the implications for the training, practice and recognition of biologists working in this area and develop recommendations for the pursuit of sustainable development.

O62-01 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

The tragedy of losing good leaders: observational and experimental evidence of disintegrating mixed species bird flocks in a fragmented African biosphere reserve

NORBERT CORDEIRO
Roosevelt University & The Field Museum, Biology & Lifes Sciences, IL 60065, Chicago, USA

Habitat loss and fragmentation are well known agents of bird species extinctions and declining abundances in the tropics. Whether these processes affect symbiotic relationships between or among bird species remains poorly explored. Mixed species foraging bird flocks is one such relationship that has received scant attention, particularly in African forests. I therefore evaluated the consequences of forest fragmentation on mixed species foraging flocks by censusing birds in mixed species flocks in five small, isolated fragments and five widely spaced continuous forest sites in the East Usambara Mountains, Tanzania. Results showed that small forest fragments had significantly fewer species and reduced bird abundance compared to continuous forest. Furthermore, nuclear or leader species, which are those species that attract other flock members, were either lost or occurred in diminished numbers in fragments as compared to continuous forest. To evaluate the efficacy of nuclear species in assembling flocks, and to indirectly test the effects of fragmentation-mediated loss of such species on flock assemblage, playback experiments were used. Using vocalisations of nuclear species with playback recordings, we demonstrated that their loss in small, isolated fragments may be one factor that affects the smaller and less diverse composition of mixed species flocks in fragments. Disintegration of mixed species flocks may thus be a consequence of losing key leaders as a function of chronic forest disturbances and loss.

O62-02 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Multiple drivers influencing tree regeneration in human-modified landscapes of Atlantic forest

DEBORAH FARIA[1], ELIANA CAZETTA[1], EDUARDO MARIANO-NETO[2], JULIO BAUMGARTEN[1],
JOSÉ CARLOS MORANTE-FILHO[1], LARISSA ROCHA[1], MICHAELE PESSOA[1], FRANCISCO GOMES[2],
CRISTINA BANKS-LEITE[3], KEITH HAMER[4]
[1]Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, 45662900, Ilhéus, Brasil
[2]Universidade Federal da Bahia, Instituto de Biociências, 40170110, Salvador, Brasil
[3]Imperial College London, Faculty of Natural Sciences, Department of Life Sciences, SW7 2AZ, London, United Kingdon
[4]University of Leeds, School of Biology, LS2 9JT, Leeds, United Kingdon

Background: Forest regeneration is shaped by a myriad of ecological processes affected by natural and anthropogenic factors, but there is a dearth of information regarding the relative importance of each process responsible for the resulting tree assemblages.
Method: We used a dataset on adult and juvenile trees from twenty forest sites in the Atlantic Forest and using path analysis we tested a model predicting that the amount of forest cover at the landscape-scale (~3.14 km^2) affects the local diversity (abundance and richness) of juveniles of shade tolerant species both directly and indirectly, as a cascading response of specific changes at local scale, including forest structure (habitat association), diversity of the established tree assemblages (seed source), abundance of mutualists (seed dispersers) and antagonists (shade-intolerant species).
Result: We found that species richness of juvenile shade tolerant assemblages is negatively affected mostly by the direct reduction of forest cover, whereas the local abundance is mainly indirectly affected by changes in forest cover, in this case as a cascading response of changes in the abundance of local tree as seed source and specific alterations in forest structure. We found no evidence that changes in the abundance of antagonists or mutualists explained local diversity juvenile shade tolerant species.
Conclusion: Our study indicates that the reduction of landscape-scale forest cover triggers a decreasing availability of adults as a local seed source and alters the structural architecture of forest layers, probably causing alterations in the microclimatic conditions of recruitment sites, and such changes are limiting forest regeneration in deforested landscapes. Under the current scenario, the diversity of shade-tolerant assemblages in fragments immersed in low-forested landscapes is likely to increasingly diverge from the diversity expected for reference systems, due to an impairment of regeneration process.

O62-03 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

A global assessment of forest disturbance on plant regeneration: the crucial role of pollinators and seed dispersers

EIKE LENA NEUSCHULZ[1], THOMAS MUELLER[2], MATTHIAS SCHLEUNING[1], KATRIN BÖHNING-GAESE[2]
[1]Senckenberg Biodiversity and Climate Reserach Centre Frankfurt, Biodiversity and area dynamics of vertebrates, 60325, Frankfurt am Main, Germany
[2]Senckenberg Biodiversity and Climate Reserach Centre Frankfurt and Goethe Universität Frankfurt, Biodiversity and area dynamics of vertebrates, 60325, Frankfurt am Main, Germany

Plant regeneration is important for maintaining biodiversity and ecosystem functioning and depends on multiple ecological processes, such as pollination, seed dispersal, seed predation, recruitment and herbivory. Human forest disturbance affects plant regeneration processes, but previous studies focusing on these processes in isolation have shown idiosyncratic responses. We here present the first integrative meta-analysis on how forest disturbance affects the regeneration of woody plants. We compiled 129 case studies with 369 pairwise comparisons of the regeneration of 204 woody plant species in near-natural forest and forests that had been disturbed through fragmentation, bushmeat hunting, selective logging, or had been converted into secondary forest. We found that overall human impacts negatively affected plant regeneration. However, only the early plant regeneration processes, i.e. pollination and seed dispersal, were significantly reduced by human forest disturbance, whereas the effects on seed predation, recruitment and herbivory were not significant. This pattern was consistent across geographic locations and plant life history strategies. We show that pollination and seed dispersal rather than recruitment are the breaking points in the life cycle of plants in disturbed forests. Conserving pollination and seed dispersal, including the animals that provide these services to plants, should become a priority in forest conservation efforts globally.

O62-04 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Pollination ecosystem services in the interface of natural-human modified environments of a neotropical dry forest

MAURICIO QUESADA[1], MARTHA LOPEZARAIZA-MIKEL[2], OLIVERIO DELGADO-CARRILLO[1], SILVANA MARTEN-RODRÍGUEZ[1], GUMERSINDO SÁNCHEZ-MONTOYA[3], MARÍA DE JESÚS AGUILAR[1]
[1]Universidad Nacional Autónoma de México, Escuela Nacional de Estudios Superiores, 58190, Morelia, México
[2]Universidad Autónoma de Guerrero, Unidad Académica de Desarrollo Sustentable, 40900, Tecpan de Galeana, México
[3]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, México

Background: Pollination is a biotic interaction essential to ecosystem functioning and ecosystem services provisioning, on which food security for humanity depends. Around 90% of angiosperms in natural habitats and 75% of agricultural crops depend on this interaction for fruit production and genetic diversity maintenance. Human disturbances and in particular land use change threaten this interaction.
Methods: We evaluated plant-pollinator interactions comparing natural and human modified environments in a tropical dry forest of the Pacific coast of Mexico: a) at the community level; b) focusing on the dioecious Spondias purpurea, the main managed species of this forest, grown for its edible fruits and also harvested from the wild; c) in animal pollinated agricultural crops, and focusing pollinator efficiency on the cultivated squash Cucurbita moschata. The study was carried out in the Chamela Cuixmala Biosphere Reserve and its surrounding area of influence.
Results and discussion: We found a great diversity of plant-pollinator interactions, with more generalized interactions under early secondary succession, where availability of floral resources was higher. The most abundant pollinators were three social bee species that are active all year around: Apis mellifera, Trigona fulviventris, and T. nigra. These species were also the main pollinators of S. purpurea. Populations of natural and altered habitats did not differ in visitation rates, nor in sex ratios (1:1); however, fruit set was higher in conserved forest. Trees from altered habitats flowered earlier and produced more flowers (male and female individuals) than trees from conserved forests, though the number of pollen grains per flower were higher at the conserved forest. In agricultural landscapes, we recorded 22 pollinator species on seven animal pollinated crops, Apis mellifera accounting for 70% of the visits. For C. moschata, the main visitors in the rainy season were Peponapis spp. Exclusion experiments show that one visit to female flowers provides enough pollen to set fruit. We found seasonal changes in the pollinator assemblage of this species, A. mellifera attaining greater importance during the dry season. Most animal pollinated crops provide floral resources to pollinators only during a few months of the dry season, while their three main pollinator species are the same social bees that are active all year around; therefore are highly dependent on forest floral resources to survive.

O62-05 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Corridors are pollination highways in tropical fragmented landscapes

URS KORMANN[1], TEJA TSCHARNTKE[2], MATTHEW BETTS[1], ADAM HADLEY[1], DOUGLAS ROBINSON[3], CHRISTOPH SCHERBER[4]
[1]Oregon State University, Forest Ecosystems and Society, 97331, Corvallis, USA
[2]Georg August Univesity, Agroecology, 37077, Göttingen, Germany
[3]Oregon State University, Fisheries and Wildlife, 97331, Corvallis, USA
[4]University of Munster, Institute of Landscape Ecology, 48149, Munster, Germany

Background: The rapid loss of tropical forest worldwide imperils biodiversity and puts tropical ecosystem functioning and ecosystem services such as pollination at risk. Pollinators are particularly crucial components of terrestrial biodiversity in the tropics, where they ensure the pollination of > 94% of higher plant species. Corridors may facilitate pollinator and pollen movement between habitat fragments, but it remains unclear whether they may avert deforestation-driven breakdown of pollination mutualisms in fragmented tropical landscapes.
Methods: We combined experiments with observational data to determine the effect of corridors on four key aspects of hummingbird-mediated pollination in a highly fragmented landscape in Southern Costa Rica. We used resource manipulation experiments, artificial flowers and experimental plants to determine whether corridors facilitate hummingbird movement and pollen transfer between forest fragments surrounded by intensive agriculture. Further, we determined pollinator patch occupancy and pollination success in small forest fragments.
Results: Resource manipulation experiments showed that corridors facilitate movement of forest-associated hummingbirds through agriculturally modified habitat and increase pollen transfer. Further, corridors strongly increased forest-associated pollinator availability in small fragments, and increased pollination success. Importantly, isolated patches without corridors showed near-complete pollinator absence, paralleled by pollination failure.
Discussion: Our results indicate that simple corridor elements benefit tropical forest ecosystems beyond boosting local species richness, by functionally connecting mutualistic network partners. Overall, our results indicate that small-scale adjustments to landscape configuration with simple corridors are a promising conservation tool to enhance native pollinators and pollination services in tropical human-modified landscapes worldwide. Corridors may therefore complement large-scale conservation strategies such as parks and represent low-cost – big-gain tools for the conservation of tropical biodiversity in the Anthropocene.

O62-06 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Multiple drivers of anthropogenic disturbance affect the structure of plant-frugivore networks

CARINE EMER[1], FERNANDA RIBEIRO[2], MARCO AURÉLIO PIZO[1], MILTON CÉZAR RIBEIRO[1], JOHN RIBEIRO[1], PEDRO JORDANO[3], PAULO GUIMARÃES JR[4], MAURO GALETTI[1]
[1]Universidade Estadual Paulista Julio de Mesquita - UNESP, Ecology, 13506900, Rio Claro, Brazil
[2]Universidade Estadual de Campinas - UNICAMP, Ecology, 13083970, Campinas, Brazil
[3]Consejo Superior de Investigaciones Cientificas - CSIC, Doñana Biological Station, Sevilla, Spain
[4]Universidade de São Paulo - USP, Ecology, 05508-900, São Paulo, Brazil

How anthropic disturbance affects key ecosystem processes and services has become a major task for ecologists. Some ecological services are associated with networks of species interactions. Yet the synergistic effects of multiple drivers of changes on plant-animal network structures are still to be unfolded. Seed-dispersal mutualisms are especially fragile to disturbances in tropical species-rich ecosystems where most plant species rely on animal-dispersal services. Here we analysed 16 plant-frugivore networks to test whether their structure changes as human disturbance increases along the heterogeneous Atlantic Rainforest biome. Disturbance was estimated threefold: first, for each network we attributed a rank of disturbance based on habitat fragmentation, degradation, restoration and defaunation; second, we calculated fragment isolation and functional connectivity of each network at the landscape level; and third, we tested whether interactions are spatially nested from more to less conserved habitats. Network structure was assessed by weighted connectance, modularity, nestedness, and specialization. Linear models were applied to test whether the mean rank of disturbance, the synergistic effect of different disturbances and the landscape metrics affect network parameters. As the rank of disturbance increases, networks become more connected, modular and interactions more specialized (all $p < 0.03$). Defaunation and fragmentation were the main drivers of network changes. Similarly, as the fragment becomes more isolated and less connected in the landscape, networks become smaller, more connected, modular and interactions more specialized whilst nestedness decreases (all $p < 0.05$). Modularity and specialization increasing with disturbance suggest the loss of frugivore generalist species and its interactions that would otherwise connect the whole network. This is likely to be related to a decreasing on species abundance and local extinctions, observed on the downsizing of networks in more defaunated and isolated fragments. Besides generalist species rely on a diversity of partners to persist, which are not expected to occur in highly disturbed areas. As interactions were not spatially nestedness and network nestedness decreased with area isolation it may suggest plant-frugivore communities are losing not only the local network connectors but also the landscape ones, which may affect long-term network persistence and forest dynamics at different scales.

O62-07 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Anthropogenic disturbance and climate change reduce seed dispersal and anti-herbivore protection services provided by ants to plants

INARA LEAL[1], LAURA LEAL[2], FERNANDA OLIVEIRA[2], TALITA CÂMARA[2], XAVIER ARNAN[2], ALAN ANDERSEN[3]
[1]Universidade Federal de Pernambuco, Botany, 50670901, Recife, Brazil
[2]Universidade Federal de Pernambuco, Plant Biology Post-Graduate Program, 50670901, Recife, Brazil
[3]CSIRO Land & Water, Tropical Ecosystems Research Centre, 0822, Winnellie, Australia

Tropical landscapes have experienced extensive habitat loss and fragmentation, and much remaining habitat is affected by chronic anthropogenic disturbances (CAD) such as the collection of forest products and livestock production. This disturbance is typical of the Brazilian Caatinga, a semiarid vegetation that supports a very dense and low-income rural populations that are highly dependent on forest resources for their livelihoods. The Caatinga biota is also threatened by climate change (mean temperature is predicted to increase by 1.8-4°C and rainfall to decline by 22% by 2100), which could amplify the negative effects of disturbance. Here we summarize our studies of the interactive effects of increasing CAD (i.e. an index combining five surrogates of CAD: density of people and livestock, and proximity to urban center, houses, and roads) and decreasing rainfall (from 940 to 510 mm/year) on two important ecosystem services that ants provide to plants in Caatinga: seed dispersal and anti-herbivore protection of extrafloral nectary- (EFN) bearing plants. We observed that the occurrence of high-quality disperser ants (e.g. Dinoponera quadriceps and Ectatomma muticum) decreased with increasing disturbance and decreasing rainfall. As a consequence, seed dispersal services (i.e. numbers of interactions, number of removals and removal distance) were markedly reduced as disturbance increased and rainfall decreased. Regarding plant protection, ant attendance was reduced as disturbance increased and rainfall decreased and dominated by the generalist ant Camponotus crassus. The reduction in ant attendance was even more accentuated in EFN-bearing plant species which abundance decreased in more disturbed and drier areas. This suggests that abiotic conditions in more disturbed and drier areas are stressful for some plant species, resulting in lower quantity or quality of EFN secretions and therefore reduced attraction of ants. Our findings are consistent with the emerging scenarios of human activities leading to ecosystem services loss. Under the projected climate change scenarios for Caatinga, the reduction of seed dispersal and anti-herbivory plant protection services provided by ants has important implications for plant recruitment and, consequently, for the future structure and composition of plant communities in this ecosystem.

O62-08 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Relationships among Landscape Structure, Ecological Processes, Biodiversity and Ecosystem Services – Interface Project

JEAN PAUL METZGER
Departamento de Ecologia, Instituto de Biociências – USP, Rua do Matão, 321, travessa 14, 05508-900, São Paulo, Spain

Understanding how landscape structure modulates different ecosystems services is today one of the main challenges of landscape ecology. To explore those relationships, a new project called "Interface Project" has been implemented tow years ago in Brazil. This project aims to investigate how parameters of landscape structure directly or indirectly regulates key ecosystem services through influencing a series of distinct ecological processes. By considering these relationships for 23 landscapes located in distinct agricultural matrices (coffee and cattle pasture), with different forest cover, within a highly biodiverse and threatened biome (Brazil's Atlantic Rainforest), we aim to contribute to an improved understanding of how landscape structure influences ecosystem services, and specifically investigate the likelihood of thresholds and trade-offs in service provision. We are considering regulatory (i.e. pollination, pest and disease control, hydrologic flow regulation and water quality), provisioning (i.e. water storage) and supportive services (i.e. carbon stocks). We will present here the first main results of this project showing, particularly, that forest cover at different spatial scales and proximity to forest edge affect pollination in coffee plantation, pest control service in coffee and pasture landscapes, as well as carbon stocks. These findings can provide relevant scientific subsidy to ongoing political landscape management and forest conservation planning, with the main purpose of maintaining ecosystem services in agricultural landscapes of the Atlantic Rainforest.

O62-09 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Impact of agrochemicals on native plant-insect interactions along unmanaged crop borders

PAOLA OLAYA-ARENAS, IAN KAPLAN
Purdue University, Entomology, 47907-2089, West Lafayette, USA

Background: Monarch butterflies have been undergoing a long-term population decline. One untested hypothesis to explain this decline is non-target exposure to toxic insecticides used to prevent pests from feeding on crops. Specifically, neonicotinoids a new class of insecticide applied to large acreage field crops that have lethal and sub-lethal effects on insects feeding on nectar, pollen and leaves. To date, little has been investigated on the connection between butterflies and neonicotinoids. Most insect groups outside of honey bees have been poorly studied and this is especially true for butterflies.
Method: We tagged, geo-referenced, and collected milkweed leaves from plants at varying distances from corn fields and tested them for residues of insecticides, herbicides, and fungicides using QuEChERS method and HPLC analysis. Simultaneously, we surveyed monarchs and estimated herbivory on plants at varying distances from corn fields. Data were collected from five sites in Indiana, over three sample periods in June, July, and August.
Result: The percentage of monarchs varied among and within sites, with distance and over time. The percentage of herbivory varied among sites and over time with July having fewer herbivores than August, and total herbivory varied from 15-70% of total leaf tissue consumed. The main seed-treatment used on corn, clothianidin, was present in 3-61% of milkweed samples collected early in the season (concentration= 0.3-22 ng/g). This is within the levels previously reported to have sublethal effects on monarch development.
Discussion. It seems likely that monarchs are exposed at sub-lethal and lethal clothianidin levels based on the concentrations found in our samples. The incidence of clothianidin was not strongly correlated with distance from the edge of corn fields (up to a max. 250m). This suggests that other factors (e.g., directionality, soil type, genetic variation in plant traits affecting insecticide uptake) need to be factored into non-target predictive models. Agriculture intensification may threaten non-target beneficial species and the ecosystem services they provide. Butterflies are susceptible to landscape-level changes, making them important bio-indicators of ecosystem health. Evaluating the effect of neonicotinoids in the monarch-milkweed system will help guide restoration efforts that aim to protect monarchs and pollinators that are crucial to sustaining agroecosystems.

O62-10 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

The neglected response/role of leaf-cutting ants in chronically disturbed dry tropical forests

RAINER WIRTH[1], FELIPE FERNANDO DA SILVA SIQUEIRA[2], JULIA BACKÉ[1], MARCELO TABARELLI[2], INARA R. LEAL[2]
[1]University of Kaiserslautern, Plant Ecology & Systematics, 67663, Kaiserslautern, Germany
[2]Universidade Federal de Pernambuco, Departamento de Botânica, 50670-901, Recife, Brazil

There is growing consensus that leaf-cutting ants (LCA) are key to the understanding of ecosystem transformation in human-modified landscapes. Driven by the massive proliferation of colonies, concomitant herbivory and ecosystem engineering impacts, LCAs have been demonstrated to simplify environments, homogenize tree assemblages, and modify forest regeneration dynamics via an anthropogenic-biogenic synergism. However, most of these insights are based on research in humid tropical forests, while the situation in tropical dry forests (TDF) has been largely neglected, despite the threats imposed by chronic anthropogenic disturbances.
The present study aims at mitigating this research deficit by exploring the ecosystem role of LCA communities in the Caatinga (NE Brazil) – a TDF ecosystem highly threatened by land-use intensification and climatic changes. Concretely, we (1) carried out comprehensive surveys of LCA communities including the spatial distribution of their colony densities, (2) analyzed disturbance and vegetation-related drivers of colony abundance, foraging and herbivory rates, (3) assessed ecosystem engineering impacts of LCA on nest and plot-level by measuring edaphic properties, and (4) addressed the potential effects on successional trajectories of Caatinga regeneration.
Our findings indicate a previously undocumented prevalence of LCA in the Caatinga, reflected by a rich community (5 spp.) and hyperabundant nests (7 col ha-1±11.9) with pronounced spatial aggregation (up to 34 col ha-1). Among the factors driving nest density we identified (1) road proximity (3-fold increase), (2) chronic disturbance, (3) vegetation cover and (4) rainfall. The very fact that LCA nests occupied 13% (0-48.5%) of the total Caatinga area points to a large ecosystem impact. Additional evidence indicated edaphic engineering, especially in sites with nest hyperabundance, where soil nutrient signatures were heavily modified. Finally, a 5-fold increase in biological soil crust (BSC) cover on inactive Atta nests suggests that nests may serve as nuclei of primary succession.
Our findings are consistent with an emerging role of LCA in TDF. Specifically, we propose that LCA drive secondary succession along chronic disturbance and precipitation gradients through soil engineering, herbivory and interrelations with BSC that lead to differential outcomes of successional trajectories. Further implications for the sustainability of the socioecological system are discussed.

O62-11 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Ecological consequences of feral pig (Sus scrofa) invasion in the Atlantic Forest

FELIPE PEDROSA[1], WILLIAM BERCÊ[2], FERNANDO PUERTAS[2], GABRIELLE BECA[1], ALEXINE KEUROGHLIAN[3], IVAN SAZIMA[4], MAURO GALETTI[2]
[1]Programa de Pós Graduação em Ecologia e Biodiversidade, IB UNESP, Ecologia, 13506900, Rio Claro, Brazil
[2]Instituto de Biociências UNESP, Ecologia, 13506900, Rio Claro, Brazil
[3]WCS-Brazil, WCS, 79052-070, Campo Grande, Brazil
[4]Universidade Estadual de Campinas, Museu de Zoologia, 13083-970, Campinas, Brazil

Invasion of feral pigs in the Atlantic Forest (AF) is recent, completing 2 decades. The range of the species increased five times in the last eight years, invading both natural and agricultural areas. To date, scientific evidence on pervasive consequences for Brazilian ecosystems due to feral pig invasion are inexistent. Actually, the opposite was indicated by several studies. Yet, deep investigation on the ecology of the species in the AF is urgent, due to the uncertainty of the ecological and economic consequences of the invasion. We have been a) sampling feral pig population in the fragmented AF (n=20 landscapes), b) collecting and analyzing stomachs (n=101) and c) studying the seed dispersal effectiveness of feral pigs in defaunated landscapes. We found that feral pig has probability of occupancy in the landscapes of 45.22% (± 11.18%) and a probability of detection of 16.22% (± 2.27%). Diet of feral pigs is dominated by sugarcane and maize (FO=84%), but we also found fruits (FO=25%) and intact seeds of nine plant species, from both native (5 species, 526 seeds, 18% of stomachs) and alien species (4 species, 387 seeds, 8% of stomachs). Monitoring feral pigs with camera traps provided an elusive part of the species invasion: vampire bats Desmodus rotundus feeding on the pigs' blood. After analyzing 1,801 photos and videos of wildlife from the AF (only night photos), we estimated that the frequency of encounters between vampire bats and feral pigs is 10%. The vampire bat is a major reservoir of rabies virus and about 1.4% of vampire bats are infected with rabies in the AF. Therefore, the probability of a vampire bat transmit rabies to feral pigs in the AF is 0.14%. Finally, feral pigs are playing multiple ecological work: the increasing population of the species in the AF fragments and sugarcane plantations make them ideal prey for the vampire bats, as pigs are among the preferred prey of D. rotundus, a circumstance that rises the chance of rabies outbreaks among wild mammals in the future; although consuming and dispersing alien seeds, some of which are highly invasive plants, contributing to ecosystem degradation, they are also dispersing native large-seeded species, contributing to a key role in ecosystem function.

O62-12 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
Thursday 23 June / 08:00-12:00 – Antigone1

Host-specific traits as drivers of virus infections in Neotropical bats and rodents

MARCO TSCHAPKA[1], STEFAN BRÄNDEL[1], JULIAN SCHMIDT[1], VICTOR CORMAN[2], ANDREA RASCHE[2], RACHEL PAGE[3], CHRISTIAN DROSTEN[2], SIMONE SOMMER[1]
[1]University of Ulm, Institute of Evolutionary Ecology and Conservation Genomics, D-89081, Ulm, Germany
[2]University of Bonn Medical Centre, Institute of Virology, D-53127, Bonn, Germany
[3]Smithsonian Institution, Smithsonian Tropical Research Institute, Balboa, Panama City, Panama

Habitat loss and fragmentation are serious threats to biodiversity. Especially in the tropics, habitat conversion still occurs on a large scale, often resulting in a mosaic of suitable habitat patches of varying sizes embedded in a more or less degraded matrix shaped by agriculture and other human activities. In response to habitat alterations, species assemblages often experience drastic changes, resulting in the persistence of the most adaptable species (so called generalists), while species more susceptible to environmental change often go locally extinct. Shifts in species assemblages are often associated with modifications of abundance pattern. Especially organisms resilient to habitat disturbance may benefit and increase in population densities and thus may play as reservoir species also a prominent role in the amplification and distribution of pathogens within the ecosystem.
In the present study we tested on a landscape scale in central Panama whether such habitat transformation leads to changes in population density in generalist bat and rodent species and ultimately to differences in virus prevalence. We assessed population density and life history traits like sex, age and reproductive status as possible explanatory variables for infection status. Our study highlights the effects of habitat disturbance on bat and rodent population dynamics and within that context the influence of specific host traits on virus prevalence. These interconnections between habitat degradation and pathogen dynamics are crucial for managing wildlife health and need to be considered in all conservation efforts.

O63-01 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Wildtech.mongabay.com: an online hub for conservation technology

SUZANNE PALMINTERI[1], RHETT BUTLER[2], ERIC DINERSTEIN[1], NATHAN HAHN[1]
[1]RESOLVE, Biodiversity and Wildlife Solutions, 20037, Washington, DC, USA
[2]mongabay.com, 94026, Menlo park, CA, USA

Infrequent communication, steep learning curves, and high costs can hamper the uptake of new technology in the field. How do researchers and resource managers get around these obstacles to find new tools to improve effectiveness in their work? We launched wildtech.mongabay.com as part of the mongabay.com environmental news platform to provide content on relevant technology and establish a vibrant online community sharing information on innovative uses of technology in science and conservation. We aim to facilitate the flow of information among researchers, resource managers and tech developers who may be able to provide creative solutions to on-the-ground challenges.
The site highlights emerging and existing technologies relevant to wildlife and wild places around the world through news, interviews, case studies, and stories from the field. We recruit experts to help our team assess and convey critical information about strengths, weaknesses, and potential for tools to improve resource conservation and management. Users can access the site via a tab on mongabay.com or directly at wildtech.mongabay.com. A discussion forum and Facebook page enable visitors to ask questions, comment, brainstorm, and form collaborations to help solve conservation challenges.
Its first six months generated some 35,000 views of over 80 articles on technologies ranging from acoustical sensors, to portable DNA analysis of wood samples, real-time animal monitoring, tiny camera traps, cloud-based data analysis, high-resolution panoramic cameras, and drones. Posts cover the innovative use of these tools to address illegal logging, human-wildlife conflict, wildlife crime, and a range of research questions. Interviews with engineers, researchers, and resource managers provide personal accounts of the innovation and application processes, as well as advice to young professionals with a passion for conserving biodiversity.
Technology still requires a good question; any application of technology for research and conservation should be targeted and appropriate. We want the site to engage and inspire practitioners, tech developers, and donors around the design, field-testing, and use of promising, suitable technologies in conservation and to provide honest and useful assessments of specific tools. With the dynamic nature of the tech world and the global need for improved resource management and conservation, we welcome and appreciate additional collaborators on this endeavor.

O63-02 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Why we need acoustic monitoring stations in every research station, ecolodge, and protected area across the tropics

AIDE T. MITCHELL
UPR, Biology, 00931, San Juan, Puerto Rico

Background: There is an urgent need to increase the temporal and spatial coverage of ecological data collection in response to the myriad of anthropogenic threats (e.g. extinction crisis, disease, climate change) to global biodiversity, specifically for the fauna. Acoustic monitoring can help us greatly improve our ability to monitor population change in thousands of species, but the ecological and conservation community has been slow in incorporating this technology into their monitoring and research projects.
Methods: During the last ten years, we have developed the Automated Remote Biodiversity Monitoring Network (ARBIMON), and we have demonstrated how inexpensive monitoring stations can collect a continuous stream of biodiversity acoustic data. These data can be uploaded, processed, and stored in the cloud in almost real-time and these data can easily be shared with colleagues around the world. Furthermore, analytical tools have been developed for soundscape analyses and for creating species-specific identification models. This technology can easily provide detailed and long-term data for monitoring the fauna around the globe.
Results: For example, I will show how the elevation distribution of amphibians in Puerto Rico has changed over the last 30 years, presumable due to climate change. In addition, I will compare the soundscapes of 10 tropical forest sites, and show that the total frequency/time use was highly correlated with total mammal, amphibian, and bird species richness ($r = 0.96$).
Conclusions: These examples demonstrate the power of acoustic monitoring for population and community level analyses. A global network of acoustic monitoring stations could provide detailed information on 1000s of species in real-time. Furthermore, these data will serve as an invaluable historic record; each recording is the equivalent of a museum specimen. The challenge is convincing the ecological and conservation community that the cost/benefit ratio of this approach merits a shift in the limited funds available for biodiversity monitoring.

O63-03 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Addressing the biodiversity knowledge gap in tropical countries using Gene, a mobile expedition lab

ANA RODRIGUEZ-PRIETO, MICHELE MENEGON
MUSE-Museum of Science of Trento, Tropical Biodiversity, 38122, Trento, Italy

Background: Biodiversity research is increasingly dependent on genomics, which allows the unprecedented digitization and understanding of the planet's biological heritage. DNA sequences have thus become core components of both evolutionary and ecological investigations. However, the molecular characterization of biodiversity is restricted by the lack of a cost effective and portable sequencing technology that can be applied in biodiversity-rich but economically-poor regions.
Method: DNA extraction, amplification, purification, quantification and sequencing were carried out directly in the field using optimized devices and protocols that collectively represent Gene, a portable lab. This system was developed to avoid the need for cumbersome and energy demanding equipment such as centrifuges, large refrigerators/freezers, and electrophoresis apparatus. The portable lab included a GeneOne device (Biodiversa) for the extraction, amplification and quantification of DNA and MinION sequencer (Oxford Nanopore Technologies) to sequencing of DNA.
Results: We assessed the potential of the Gene, to sequence standard barcode regions (16S and COX1) for vertebrates (amphibians, reptiles and mammals) under field-like conditions. We also established protocols for DNA barcoding under field conditions and tested the mobile laboratory in a remote tropical forest in Tanzania lacking of conventional laboratory facilities and electricity. The sequence of a wild frog captured in situ was compared with a comprehensive library of East African amphibians allowing us to rapidly identify the species.
Conclusions: Our results confirm that sequencing in the field is possible, offering the revolutionary perspective of real-time biodiversity assessment. The availability of a portable laboratory allows rapid on-site DNA sequencing and therefore rapid response to a number of different issues, i.e. presence of pathogens, high levels of inbreeding, species new to science, alien or invasive species etc. In the context of biodiversity research, the greatest advantages of Gene are: its low cost (compared to large-scale centralized infrastructures), portability and ability to function in tropical environments (high temperature and humidity). However, since this is the first time that Gene has been used in this context, in order to fully understand its potential, we stress the need of more broad tests.

O63-04 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Elucidating avian flyways in South America with satellite telemetry: state of knowledge and future directions

LISA DAVENPORT[1], TORBJØRN HAUGAASEN[2], JOÃO VITOR CAMPOS E SILVA[3], WHALDENER ENDO[2], CARLOS PERES[4], KATHARINE GOODENOUGH[5]
[1]University of Florida, Florida Museum of Natural History, 32611-2710, Gainesville, USA
[2]Norwegian University of Life Sciences, Dept. of Ecology, 1432, Ås, Norway
[3]Universidade Federal do Rio Grande do Norte, Biology, 59078-900, Natal, Brazil
[4]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK
[5]University of Oklahoma, Oklahoma Biological Survey, 73019-0390, Norman, USA

Both single- and multi-species avian flyways have been documented for parts of Europe, Asia, Africa and Australia. Waterbirds move seasonally within the Amazon in response to annual flooding that transforms wetland habitats, yet very little is known about annual avian movements within the vast wilderness of the South American Amazon. To study intra-tropical movement ecology of waterbirds, we have begun tracking two species from Amazonia, the Black Skimmer (Rynchops niger) and the Orinoco Goose (Neochen jubata), using satellite transmitters (Microwave Telemetry 5 g ARGOS PTT's), in both Peru (Río Manu) and Brazil (Río Jurua). We have preliminary evidence for strong migratory connectivity between seemingly disparate populations for both species, based on tracking migrations of a few birds from each site. Three skimmers, two from Peru and one from Brazil, undertook similar westward migrations across the Andes after the breeding season (June-October), using identical stopovers both East and West of the high Peruvian Andes. In addition, both Peruvian and Brazilian Orinoco Geese migrate to the Llanos de Moxos, Bolivia, each year after breeding. Several additional skimmers tracked from Peru provided partial migration data suggesting the importance of the Bolivian Llanos de Moxos wetlands to this species as well, possibly en route to Atlantic coastal sites. These insights into avian flyways allow us to pinpoint potential sites for targeting conservation efforts, which become ever more important as development pressure accelerates in the region. However, gaining insights for the Amazon region has so far been possible only due to the latest technology in satellite telemetry, as alternatives such as GSM are not widely available or function only at local scales. Satellite telemetry remains the most expensive technology available (~$4,000 USD per PTT, not including data download charges), imposing a lower sample size on studies than is optimal, including in our own study. In light of these cost concerns, we discuss the promise and potential pitfalls of using lower cost units from advances in GSM, UHF and light level geolocator technologies, as well as the emergence of a "maker movement" of labs producing their own units from freely available designs.

O63-05 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Detect-deter-document: A new Human - Wildlife Conflict Reduction and Insurance System

HENRIK BARNER RASMUSSEN [1], WHITE ROWENA[2], COMBES KAT[2]
[1]Rowena White, Soysambu Conservancy
[2]Kat Combes, Soysambu Conservancy

Background: Human wildlife conflict (HWC) is increasing and one of the single largest threats to the conservation of larger mammals. Lions are e.g. being persecuted to extinction for depredation on livestock and elephants being killed for crop raiding. HWC also adversely affect human social-economic development causing losses of both agricultural products and life stock.
Methods: We began the development of a novel low cost, flexible system designed to help detect and deter problem animals. The system consists of a base station (BST) deployed in the exclusion location and a RF transmitting tag deployed on the problem animal. The BST will detect (and record) any signal emitted from approaching tagged animals. When detected above a threshold strength (distance) and if belonging to a species considered a threat, the base station will automatically initialize an alarm sequences e.g. flashing light or sirens.
Results: A prototype BST including alarm module and corresponding animal tag has been successful developed and trialed. This system is currently being tested in HWC situations in cattle bomas to detect and deter known problem lions collared with GPS collars containing a dedicated RF transmitter. Initial prototypes have shown strong potential for continued success in deterring predators and potentially herbivores like elephants. Discussion The system will in itself be able to reduce incidences but combined with an insurance scheme it can document incidences with the insurance cover remaining losses. The system is promising in situation with few individuals responsible for conflict behavior and will likely reduce next generation conflict behavior via offspring conditioned to natural diets by tagged parents but less likely to work in numerous species. Once refined and in production the animal tag will cost less than 25 USD and the BST less than 300 USD thus making the system economically viable.

O63-06 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

Using lightweight unmanned aerial vehicles to monitor tropical forest recovery

RAKAN ZAHAWI[1], JONATHAN DANDOIS[2], KAREN HOLL[3], DANA NADWODNY[2], LEIGHTON REID[3,4], ERLE C.ELLIS[2]
[1]Las Cruces Biological Station, Organization for Tropical Studies, Apartado 73-8257, San Vito de Coto Brus, Costa Rica
[2]Department of Geography and Environmental Systems, University of Maryland, 211 Sondheim Hall, 1000 Hilltop Circle, Baltimore, MD 21250, USA
[3]Department of Environmental Studies, University of California, Santa Cruz, CA 95064, USA
[4]Center for Conservation and Sustainable Development, Missouri Botanical Garden, PO Box 299, Saint Louis, MO 63166-0299, USA

Traditional field-based measures for assessing forest recovery and habitat quality can be labor intensive and costly. Herewe assess whether simple remote sensing measures using digital photographs taken from lightweight unmanned aerial vehicles (UAV) are an effective substitute. The study was done in a 7-9-yr tropical restoration study in southern Costa Rica. The method utilizes overlapping aerial images taken by a consumer-grade digital camera mounted on a UAV that are then processed using structure from motion software to generate LiDAR-like (light detection and ranging) 3D 'point cloud' models of vegetation at high spatial resolutions. The results of these analyses were compared to field-based measures; their ability to predict frugivore bird abundance was also evaluated. Canopy height measurements were highly correlated with field-based measurements ($R2 \geq 0.85$), a result comparable in precision to LiDAR remote sensing but generated at a fraction of the cost. Parameters were also strongly correlated with above-ground biomass ($R2 \geq 0.81$) and percent canopy openness ($R2 = 0.82$). Correlations were weaker when compared to proportion-based measures such as canopy roughness ($R2 = 0.53$), but predicted frugivore presence and abundance at levels of accuracy similar to those of field-based measurements. Several other structure metrics were also generated using this methodology. This field-transportable remote-sensing technique provides an effective alternative to traditional field-based monitoring methods and is an important additional tool for researchers examining for structure metrics, particularly in remote areas.

O63-07 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

An Image-based Plant Identification Platform for Thousands of Species

PIERRE BONNET[1], ALEXIS JOLY[2], JULIEN CHAMP[2], HERVÉ GOËAU[3], SAMUEL DUFOUR-KOWALSKI[4], ANTOINE AFFOUARD[2], JEAN-CHRISTOPHE LOMBARDO[2], SEN WANG[2], JENNIFER CARRÉE[5], JEAN-FRANÇOIS MOLINO[3], NOZHA BOUJEMAA[6], DANIEL BARTHÉLÉMY[7]
[1]CIRAD, Amap Lab, 34000, Montpellier, FRANCE
[2]INRIA, Zenith Team, 34000, Montpellier, FRANCE
[3]IRD, Amap Lab, 34000, Montpellier, FRANCE
[4]INRA, Amap Lab, 34000, Montpellier, FRANCE
[5]Tela Botanica, 34000, Montpellier, FRANCE
[6]INRIA, 91120, Palaiseau, FRANCE(7) CIRAD, BIOS, 34000, Montpellier, France

Pl@ntNet is a large-scale participatory platform dedicated to the collection of botanical observations thanks to crowdsourcing approaches and machine learning tools [a]. This initiative, supported since 2009, has allowed developing a computational infrastructure able to propose among others, a mobile plant identification service based on automated image analysis [b]. This service, freely available on iPhone (https://itunes.apple.com/fr/app/plantnet/id600547573?mt=8) Android (https://play.google.com/store/apps/details?id=org.plantnet) and the web (http://identify.plantnet-project.org/), was initially set up for a fraction of the European flora (800 species at the beginning), and now accounts 6 000 species of the European flora, other tropical regions such as Indian Ocean flora, French Guyana flora, and North African flora. With more than one million downloads in 3 years, and a daily use of more than 6 000 people per day, the infrastructure is now able to produce a huge volume of botanical observations contributed by a wide range of actors. An impact study conducted in 2015 has allowed collecting more than 700 responses to a survey dedicated to characterize contexts of uses, and the most important needs by the community of end-users.
Based on these feedbacks, we invested in several directions such as:
. the educational perspectives of this framework in order to define specific usage scenarios at school and university levels,
. specific functionalities such as the off-line function which represents a considerable evolution given the fact that it allows to use this system in field conditions, where 3G connection is lacking, as its often the case in tropical regions, or on tropical mountain ecosystems.
We propose to present this initiative, and the latest realizations tested through this infrastructure, and discuss their potentials impacts in biological conservation, educational perspectives, and biodiversity studies.
[a] Joly A., Goeau H., Bonnet P., Bakic V., Barbe J., Selmi S., Yahiaoui I., Carré J., Mouysset E., Molino J.F., Boujemaa N., Barthélémy D. 2014. Interactive plant identification based on social image data. Ecological Informatics, 23 : 22-34.
[b] Joly A., Bonnet P., Goeau H., Barbe J., Selmi S., Champ J., Dufour-Kowalski S., Affouard A., Carré J., Molino J.F., Boujemaa N., Barthélémy D. 2015. A look inside the Pl@ntNet experience. The good, the bias and the hope. http://dx.doi.org/10.1007/s00530-015-0462-9. Multimedia Systems : 16 p.

O63-08 – S63 *Technology-driven revolutions in tropical ecology open new paths for understanding and mitigating development impacts on biodiversity*
Thursday 23 June / 14:30-17:00 – Antigone1

The history and a picture of movement ecology in Brazil

MILENE A. ALVES-EIGENHEER[1], NATÁLIA S. SILVEIRA[1], JULIA E. F. OSHIMA[1], LIGIA P. S. SALZANO[1], BERNARDO B. S. NIEBUHR[1],
Danielle C. T. L. Ramos[1], Claudia Z. Kanda[1]
[1]Universidade Estadual Paulista, Ecology, 13506-900, Rio Claro, Brazil
[2]Universidade Estadual Paulista, Zoology, 13506-900, Rio Claro, Brazil
[3]Universidade Federal do Rio Grande do Norte, Phisiology, 59078-970, Natal, Brazil

Background: Research on movement ecology in Brazil has increased significantly in the last years, but it is still sparse and fragmented. With the aim of locating and promoting integration between movement ecology researchers, the "I Movement Ecology Brazil Workshop" was held in September 2015 at São Paulo State University (UNESP), Rio Claro, Brazil. The meeting consisted of lectures, contributed talks and posters sessions and the participants discussed challenges and perspectives of this discipline in Brazil. In this contribution, we aim at synthesizing the state of the art of movement ecology in Brazil, based on both literature review and the results of the workshop.
Method: All the participants were invited to answer a questionnaire related to their study groups, kinds of technology and analysis used and research greatest challenges. We compiled the answers to the discussions promoted during the meeting to present a picture of movement ecology in Brazil. The synthesis of the meeting was complemented with a literature review of 30 years of research articles on movement ecology in Brazil, performed at the Web of Science.
Result: The event gathered researchers of more than 30 South-American institutions. The main methods used by the Brazilian movement ecology researchers are GPS and radio-telemetry, but the use of innovative technologies as accelerometers and sound-telemetry is increasing. Mammals and birds are the most studied taxa. The participants agreed that the greatest challenges on movement ecology in Brazil are data analysis, financial support and difficulties with new technologies, besides the few integration between researchers. Furthermore, there is a lack of studies with a deeper ecological approach, correlating movement and fundamental processes to ecosystems maintenance.
Discussion: Movement ecology studies in Brazil have increased exponentially on the last 10 years and this meeting was important for the presentation of the principal difficulties encountered by researchers, as well as to the discussion of solutions for the greatest challenges. The main recommendations to the meeting participants were a higher focus on ecological questions, data sharing on virtual databases and a better integration between researchers. Our synthesis on movement ecology is essential to conservation in countries

with large biodiversity as Brazil, once that they can provide important information for management plans for species and biomes.

O64-01 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

The vegetation of Central Africa: a biogeographical perspective

H. PETER LINDER
University of Zurich, Systematic Botany, 8008, Zurich, Switzerland

Background: Central Africa has five quite distinct biomes. The African rainforests have been recognized as a distinct region in all African biogeographical studies, separated from the savannas to the north and the south, the dry scrub forests in East African, and the montane forests in the Western Rift. This distinction is based on sets of shared species of plants, birds, mammals, frogs and snakes. However, the boundaries to the adjacent regions may be interpreted very differently, depending how diverse elements are weighted. This is partially because some of the transitions are in the forms of geographical mosaics (rainforest species penetrating deep into savanna regions along rivers, forming gallery forests) or because the local composition of the species gradually changes (the transition to montane forest along the plateau and peaks flanking the Rift Valleys). The other variable is how many regions should recognized in the rainforests. Generally three are distinguished (West Africa, the Congo Basic, and the East African coast), but this hides a huge complexity, expressed both as variation in species richness, and in variation of where the highest turnover in species composition is.
Methods: We used an already available dataset on the distribution of plant species in Africa. In this dataset species are scored for presence at a 1-degree scale across Africa. We focused on the rainforest areas and their perimeters, and sought patterns in these data with diverse multivariate analyses (clustering and ordination approaches).
Result: We find that the rainforests across Africa form a coherent phylogeographical cluster, this can be separated into three sub-regions (West Africa, Congo basin and East Africa). There are centres of richness and endemism in Cameroon, the Crystal Mountains and along the Western Rift, whereas the central Congolese basin is species-poor.
Discussion: Our analyses confirm the well-established pattern of regions in the African rainforests. This regionalization suggests that the forests were at times restricted to a small number of refugia, currently recognized as centres of endemism (in West Africa, at Mt Cameroon, in the Crystal mountains and in the Western Rift. However, this method cannot date these refugia. The northern and southern savannas are distinct, but it is unknown whether they or other vegetation types occupied the Congo basin when the forests retreated.

O64-02 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Phytogeography, (phylo)diversity and threatened species of tropical Africa: new insights from a mega database on the distribution of tropical African vascular plants

GILLES DAUBY[1], THOMAS COUVREUR[1], VINCENT DROISSRT[2], STÉVART TARIQ[3], RAINBIO CONSORTIUM[4]
[1]Institut de Recherche pour le Développement (IRD), UMR DIADE, 64501, Montpellier, France
[2]Institut de Recherche pour le Développement (IRD), UMR AMAP, 64501, Montpellier, France
[3]Missouri Botanical Garden, Africa & Madagascar Department, 63110, Saint Louis, USA
[4]FRB, CESAB, 13100, Aix-en-Provence, France

Background: African tropical forests are highly diverse but are undergoing negative shifts in response to climate changes and increasing anthropogenic pressures. Documenting species distribution is thus of fundamental importance for understanding vegetation responses to ongoing global changes. Unfortunately, to date, distribution data on tropical African plants were scattered among institutions and individual collections, with little taxonomic coherence between these datasets. Our goal was to synthesize available data on vascular plant species distribution across sub tropical Africa in a single and comprehensive database in order to (1) provide insights into phytogeographical delimitation of Tropical Africa (2) to provide a global conservation assessment of all plant species at the sub tropical African level by generating preliminary conservation status assessments and extinction risk maps.
Methods: We compiled 13 datasets of vascular plant species distribution into a single database called RAINBIO. We applied several quality checks and used taxonomic expertise to improve the quality of the herbarium specimens' datasets. For aim (1), analyses were based on (i) compositional (i.e. floristic) and (ii) phylogenetic similarities. They were performed for all vascular plant species and for specific plant life-forms (trees, herbs, lianas and epiphytes) in order to verify their congruence. For Aim 2, we developed an R package, ConR, to perform automatic and rapid preliminary assessments of conservation status following criteria A and B and categories of the IUCN.
Results: RAINBIO contains over 600,000 unique georeferenced occurrences for over 24,000 species of vascular plants across sub Saharan tropical Africa.
We provide up-to-date phytogeographical delimitations for Afrotropical region. While floristic-based analyses provides strong geographical signal in clustering, the phylogenetic-based ones tend to cluster ecologically similar areas.
Fast-track evaluation of conservation assessment enables the preparation of a preliminary list of threatened species for countries and the identification of areas with high concentrations of threatened species.
Conclusion: RAINBIO provides a unique view into the diversity of sub Saharan plant species distributions and new insights into phytogeographical and phylogenetic plant patterns of Africa. Finally, our results suggest that around 50% of all plant species may be potentially threatened with extinction.

O64-03 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Patterns of tree species composition across tropical African forests and within central African moist forests: the need for adapted management and conservation strategies

SYLVIE GOURLET-FLEURY1, ADELINE FAYOLLE2, JEAN-LOUIS DOUCET2, MICHAEL D. SWAINE3,
[1]CIRAD - Department : BSEF, F 34398 Montpellier - France
[2]Gembloux Agro-Bio Tech, Université de Liège Foresterie tropicale, Gestion des Ressources Forestières BIOSE Department 5030 Gembloux - Belgique
[3]University of Aberdeen Department : Institute of Biological and Environmental Sciences Aberdeen - United Kingdom

Background: Differences in the distribution of biota across Africa have been described for well over 100 years. There is however little information on the forest types at a regional scale. In this study we aimed to identify large-scale variation in tree species composition across tropical Africa, and within central Africa, to detail the structure and functioning of moist forests.
Methods: Distribution data were gathered for 1175 tree species in 455 samples from the literature scattered across tropical Africa, from Senegal to Mozambique, and including all types of tropical forests. The value of elevation and 19 climatic variables (BIOCLIM) were assigned to each sample. Management forest inventory data were assembled for 49,711 0.5-ha plots across central Africa, covering an area of more than six million hectares. Using ordinations, we determined the variations in species composition across tropical African forests and for central African moist forests we used both genus composition and forest structure. We defined floristic clusters and identified the characteristic species/genera at both levels of resolution. Results: We found floristic evidence for three main biogeographic regions across the tropical African forests, and described six floristic clusters with particular environmental conditions within these regions: Coastal and Upland for East Africa, Dry and Wet-Moist for West Africa, and Moist and Wet for Central Africa. Within the central African moist forests, we identified 7 forest types based on genus composition and forest structure. Most of these forests were composed of a mosaic of the structural derivatives of the Celtis (Ulmaceae) forest. Secondary Musanga (Moraceae) forest was located along roads and around main cities; mixed Manilkara (Sapotaceae) forest covers a huge area in the Sangha River Interval; and monodominant Gilbertiodendron (Fabaceae) forest was sparsely distributed along rivers.
Conclusions: The forest types identified across tropical African forests and within central African moist forests call for adapted management and conservation strategies. Specifically, the old-growth secondary Celtis forests that cover huge areas in central Africa should be managed for future timber productions, possibly complemented by artificial regeneration while the very specific and low productive Manilkara forests should be carefully managed with lower intensity practices.

O64-04 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Complementarity of environmental factors explain spatial floristic variations in mixed lowland rainforest of Cameroon

MOSES LIBALAH[1], VINCENT DROISSART[2], NICOLAS BARBIER[2], BONAVENTURE SONKÉ[1], DONATIEN ZEBAZE[1], GILLES DAUBY[3], GISLAIN MOFACK[1], NARCISSE KAMDEM[1], NICOLAS TEXIER[3], PIERRE PLOTON[2], RAPHAEL PÉLISSIER[2], STÉPHANE MOMO[1], PIERRE COUTERON[2]
[1]Laboratory of Plant Systematics and Ecology, Biology, Higher Teachers' Training College, 00237, Yaounde, Cameroon
[2]Institut de Recherche pour le Développement (IRD), Unité Mixte de Recherche AMAP, 34398, Montpellier cedex 5, France
[3]Herbarium et Bibliothèque de Botanique Africaine, Université Libre de Bruxelles, 1050, Bruxelles, Belgium

Background. Analyzing floristic composition is important to understand species diversity and its response to varying environmental factors. As such, focus of previous papers has been on selected species or local scales. We assessed the explanatory power of environmental factors on species distribution in central African rainforest. We aimed to determine floristic gradients and question the extent to which soil and/or climate could explain these gradients.
Method. We sampled 61 1-ha plots (407 species, 28,944 individuals with diameter at breast height above 10 cm) distributed over six sites in evergreen to semi-deciduous forests on about 100,000 km^2 area. Bioclimatic variables (temperature, precipitation) were extracted from newly improved remote sensing datasets and assigned to each plot. On a subset of 28 plots, 14 soil chemical and physical properties were also analyzed. We determined variation in species composition by correspondence analysis (CA) that emphasizes scarce species and non-symmetric correspondence analysis (NSCA) that emphasizes abundant species. In order to link floristic gradients to soil/or climate, we apportioned the total floristic variances with respect to the environmental factors.
Result. Floristic gradient was depicted by scarce species (Funtumia africana, Baphia leptobotrys) and observed a north-south shift concomitant with a prominent precipitation gradient on axis 1 (66.8% variance). The response of abundant species (Greenwayodendron suaveolens, Tabernaemotana crassa) was evident only at the third axis (16.6% variance) but poorly correlated with soil and climate gradients. Independently, soil explained more total variance (CA; 55.5% & NSCA; 56.2%) than climate (CA; 29.9% & NSCA; 34.3%). A residual analysis showed that soil and climate were non-redundant in predicting floristic variations. Both factors explained as much as 75.9% of floristic variation while this proportion sharply dropped when either the effect of soil or climate was factored out. While climate (precipitation intensity) discriminated forest sites (i.e. large spatial scale), soil properties (texture) differentiate plots (i.e. local spatial scale).
Conclusion. Our study highlights the influence of soil and climate in regulating floristic variation in central African rainforests. It emphasizes on the importance of accounting for both scarce and abundant species and recommends that non-environmental factors be considered to capture variation in abundant species.

O64-05 – S64 *Towards an unified vision of the central african forests*
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Can we predict forest composition across space and time in Central Africa

MAXIME RÉJOU-MÉCHAIN[1], FRÉDÉRIC MORTIER[2], NICOLAS BARBIER[3], JEAN-FRANÇOIS BASTIN[2], FABRICE BÉNÉDET[2], XAVIER BRY[4], JÉRÔME CHAVE[5], GUILLAUME CORNU[2], GILLES DAUBY[6], JEAN-LOUIS DOUCET[7], ADELINE FAYOLLE[7], SYLVIE GOURLET-FLEURY[2]
[1]French Institute of Pondicherry, LIAG, 605001, Pondicherry, India
[2]CIRAD, UPR BSEF, 34398, Montpellier, France
[3]IRD, UMR AMAP, 34000, Montpellier, France
[4]Université Montpellier, UMR I3M, 34095, Montpellier, France
[5]CNRS, UMR 5174 EDB, 31062, Toulouse, France
[6]IRD, UMR DIADE, 34000, Montpellier, France
[7]Gembloux Agro-Bio Tech, Unite de gestion des ressources forestieres et des milieux naturels (GRFMN), 5030, Gembloux, Belgium

Background. Predicting the current and future natural distributions of species is challenging, especially in the tropics where large remote areas remain poorly known. Such challenge can only be met with an in-depth understanding of the drivers of species distribution, a well-designed and extensive survey and appropriate statistical models.
Method. In this study, we use a large dataset of forest inventories from logging companies, which provides information on the abundance of 123 tree genera, in 140,000 plots spread over four Central African countries. In order to predict the current and future distribution of these tree genera, we use a set of bioclimatic, geological and anthropogenic variables. We rely on a recently published methodology, called Supervised Component Generalized Linear Regression (SCGLR), which identifies the most predictive dimensions among a large set of predictors.
Result. Using a calibration and validation scheme, we show that the distribution of most tree genera can be well predicted over the whole study area at the present time. At the community level, the floristic and functional composition of tree genera is also inferred with a good accuracy. Finally, using spatially explicit null models, we show that species-climate association are in most cases not better than chance, thus challenging our ability to predict how forest composition will be affected by climatic changes.
Conclusion. Overall, our study shows that tropical tree distributions can be predicted with good accuracy at the present time, offering new perspectives to manage tropical forests at large spatial scales, but that predicting shifts in species distribution under climate change scenarios is challenging.

O64-06 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Functional shifts within Central African rainforests

JEAN-FRANCOIS BASTIN[1], FRÉDÉRIC MORTIER[1], MAXIME RÉJOU-MÉCHAIN[1], FABRICE BÉNÉDET[1], GUILLAUME CORNU[1], JEAN-LOUIS DOUCET[2], ADELINE FAYOLLE[2], MAHLET TADESSE[3], SYLVIE GOURLET-FLEURY[1], RAPHAEL PÉLISSIER[4]
[1]CIRAD, UPR BSEF, F-34000, Montpellier, France
[2]Gembloux Agro-Bio Tech, Unité de gestion des ressources forestieres et des milieux naturels, 5030, Gembloux, Belgique
[3]Georgetown University, Department of Mathematics and Statistics, DC, Washington, USA
[4]IRD, UMR AMAP, F-34000, Montpellier, France

Background: Understanding the reaction of ecosystems to climate change and anthropogenic pressure is a central question in ecology and environmental sciences. In the terrestrial tropics, theoretical and empirical works suggest that once external disturbances have reached a given threshold, forest-savanna systems can switch from one state to another. Considering the multiplicity of the tropical forest systems, we make the assumption that numerous shifts may actually occur within the forest itself, without changes in forest cover but with risks of critical modifications in forest functioning.
Methods: To test this hypothesis, we used a finite mixture of regression models aiming at simultaneously predicting and grouping forest functional profiles at the stand level with respect to anthropogenic pressure, climate and soil. The model is built on a dataset of more than 140 000 plots of 0.5-ha each gathered from Central African forest companies. Forest stand functions are analyzed through two key functional traits: the successional status - pioneer vs. non-pioneer trees- and the leaf phenology - evergreen vs. deciduous trees.
Results: Our model captured a significant part of variation in the functional composition over the study area and revealed how anthropogenic pressure, climate change, soils or their combination lead to profound modifications within the forests. In particular, we showed that shifts from evergreen to deciduous stands can be mediated both by anthropogenic pressure or climate change.
Discussion: This work shows for the first time how external forcing may jointly lead to multiple shifts in the functional composition of tropical forests. Our model allowed to predict directional changes in forest functioning according to anthropogenic pressure and climate thus opening new perspectives in theoretical ecology, global vegetation modelling and in the understanding of the vulnerability of tropical forests to global changes.

O64-07 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Gateway to the Forests of Central Africa: towards a unified collaborative model of forest dynamics

CLAUDE GARCIA[1], JEAN-FRANÇOIS BASTIN[7], MAXIME RÉJOU-MÉCHAIN[6], JULIETTE CHAMAGNE2, GILLES DAUBY[8], GAËLLE VIENNOIS[9], VINCENT DROISSART[5], HÉLÈNE DESSARD[1], TARIQ STÉVART[10], OLIVIER HARDY[11], PAULINE GILLET[3] CÉDRIC VERMEULEN[3], VALÉRY GOND[1], ADELINE FAYOLLE[3], FRANÇOIS BRETAGNOLLE1[2], JOHAN OSZWALD[4], JEAN-LOUIS DOUCET[3], SYLVIE GOURLET-FLEURY[1], RAPHAËL PÉLISSIER[5]
[1]CIRAD, ES, 34398, Montpellier, France
[2]ETH, FORDEV, 8092, Zurich, Switzerland
[3]Universite de Liege, Gembloux Agro-Bio Tech, 5030, Gembloux, Belgium
[4]University of Rennes, 35000, Rennes, France
[5]IRD, UMR AMAP, 34000, Montpellier, France
[6]French Institute of Pondicherry, Geomatic Lab, 605001, Pondicherry, India
[7]Université Libre de Bruxelles, Landscape Ecology and Plant Production Systems Unit, 1050, Brussels, Belgium
[8]Université Libre de Bruxelles, Evolutionary Biology and Ecology, 1050, Brussels, Belgium
[9]CNRS, UMR AMAP, 34000, Montpellier, France
[10]Université Libre de Bruxelles, Herbarium et Bibliothe`que de Botanique africaine, 1050, Brussels, Belgium
[11]Université Libre de Bruxelles, Laboratoire de Génétique et Ecologie Végétales, 1050, Brussels, Belgium
[12]Université de Bourgogne, 21078, Dijon, France

Background: The tropical forests in general, and those of Central Africa in particular, stand at the cross-road. The combined and interacting effects of land-use change, resource extraction, defaunation, fire, fragmentation and climate change are pushing these ecosystems towards critical points where transitions to altered states will happen. The future of these forests depends on our capacity to understand and anticipate these transitions, and to identify these states the forest ecosystems are likely to take. Yet, to date, there was not a unified model that presented the best available knowledge on the forest dynamics of the regions. The field is highly fragmented and we lack a general overview.
Method: We propose here a general unified model of forest dynamics in Central Africa. This model represents the best available knowledge on the topic and is the result of a collaborative effort based on expert knowledge and an analysis of the literature. We built it using methods issued from the fields of facilitation, participatory modelling and team science.
Result: Our model identifies the main forest types present in the area, the dynamic links and possible transitions between them and the potential impacts of environmental factors - climate, soil, large mammals - and human factors - logging, fire, clearings. It provides a description of these forest types and allows the layman to grasp the general dynamics at play in the region. For those willing to deepen their understanding, we provide all the necessary literature leads to guide them in their discovery of the topic.
Conclusion: Our aim is to propose as an easy to access gateway for those needing to take decisions on how to manage the forests of Central Africa in the coming decades. It sums up our current understanding of the system, helps chart knowledge gaps and highlight avenues for future research, serving as basis for discussions. An accepted common understanding of the dynamics of these forests will be solid foundation for alternative modes of management to emerge, we hope it will foster dialog between key stakeholders, and generate better informed decisions, more resilient to surprises.

O64-08 – S64 *Towards an unified vision of the central african forests*
Thursday 23 June / 08:00-10:00 – Antigone3

Ethnophotography of Sciences: using photography to foster transdisciplinarity in the forest landscapes of Cameroon.

ARNAUD DE GRAVE[1], JULIETTE CHAMAGNE[2], CLAUDE GARCIA[3]
[1]Ecopaimpseste, 11510, Fitou, France
[2]ETHZ, ForDev Group, 8044, Zurich, Switzerland
[3]CIRAD, ES, 34398, Montpellier, France

The future of the forests of Central Africa is constrained by land use decisions and the response of the socio-ecosystems to global change. The purpose of the CoForTips project is to promote better management of the forests of the Congo Basin, by fostering dialogue between stakeholders. We seek to develop a framework for transdisciplinarity, for collaboration between social and natural sciences, between stakeholders and researchers. How to shift from a collection of fragmentary perceptions of the system to a comprehensive and broad understanding of the multiple perspectives held by each stakeholder?
Alongside other forms of classical research and engagement – interviews, participant observation, participatory modelling – we propose one additional way to foster transdisciplinarity. We have called this approach ethnophotography of sciences. At the core, it uses photography as a medium to confront the perceptions of researchers and stakeholders. It associates long stays in the field, an unconditional positive attitude derived from the field of facilitation, and observant participation. Coupled to the workshops of participatory modeling, the photographer documents the daily life and work of the inhabitants, the researchers in the field and their interactions with locals, and integrates their visions and perceptions of the landscape, its resources and actors in the shooting process. This is done through discussion with the «models» about the way they want to be portrayed, instant photography for quick feedback and pre-exhibition editing evaluation in collaboration with researchers in Europe and on site.
What we propose here is not a talk or a poster, but an exhibition, made of diptychs, with a different take on moments of life as it is experienced in the villages around Mindourou, Cameroon, one of the study sites of the CoForTips project. Each picture, each diptych and the entire set can be understood as boundary objects, bringing the gap between stakeholders and academics.
Our aim is to spark a discussion between an audience used to watch these systems through the lenses of the academia, and that of the villagers, who shaped the way in which they were represented by the photographer.

O65-01 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Modeling sustainability in multiple use protected areas: hunting, food security, and land use change

SILVIUS KIRSTEN M[1], IWAMURA TAKUYA[2], FRAGOSO JOSÉ MV[3], LAMBIN ERIC F[4], LUZAR JEFFREY B[5]
[1]Virginia Tech, FREC, 24061, Blacksburg, USA
[2]Tel Aviv University, Faculty of Life Sciences, 6997801, Tel Aviv, Israel
[3]California Academy of Sciences, Institute for Biodiversity Science and Sustainability, 94122, San Francisco, USA
[4]Stanford University, Woods Institute for the Environment, 94305, Palo Alto, USA
[5]Stanford University, Department of Anthropology, 94305, Palo Alto, USA

Iwamura et al. (2016) used a spatially explicit, agent-based simulation model representing human livelihoods, forest dynamics, and animal meta-populations to examine how land conversion, changes in hunting practices, changes in human demography, and food supplement policies impact the sustainability of human-environment interactions on delimited protected areas. Land use change outside the protected area initially impacted forest and animals within the area, but the system was resilient to these impacts, establishing a new equilibrium at lower but ecologically robust forest cover and animal population levels. Resilience was also observed in the case of improved health care (modeled as changes in child mortality) and changes in hunting practices. The introduction of external food resources, however, caused large fluctuations in the system—no new equilibrium was reached between humans and resources, and significant environmental degradation ensued. Based on these results, we develop a conceptual model of protected area sustainability that includes hunting management and addresses the trade-offs inherent in the multiple objectives of protected areas and indigenous lands in the Amazon—protection of local livelihoods, contribution to national level biodiversity conservation goals, and provision of environmental services at multiple scales.

O65-02 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Untangling the legal path for the sustainable use and trade of wildmeat by rural communities in Colombia

NATHALIE VAN VLIET[1], JUANITA GOMEZ[2], SEBASTIÁN RESTREPO[2], GERMÁN ANDRADE[3], JOHN FA[1], ROBERT NASI[1]
[1]CIFOR, BRI, 0000, Bogor, Indonesia
[2]Fundación SI, SI, 0000, Bogota, Colombia
[3]Instituto Alexander von Humboldt, 0000, Bogotá, Colombia

Existing legal frameworks in many user countries lack clear definitions of sustainable use rights by rural communities, and often fail to provide well-defined pathways for enabling the use of wildmeat at sustainable levels to meet legitimate needs. In Colombia, more flexible regulatory bases for the sustainable use of natural resources were included in the 1991 Constitution, recognizing the sovereignty of indigenous communities and their right to regulate the use of their natural capital. Under the Colombian law, subsistence hunting may be carried out throughout the national territory, but only for own consumption. Under the current definition of subsistence hunting the trade of game to cover other basic needs e.g. house rents, health, education, or to acquire commercially available food items, is considered commercial hunting, and is therefore forbidden. Rural hunters are in principle able to sell wildmeat if they obtain a legal permit issued by the Regional Environmental authority under complex requirements. However, there are no operational frameworks under the regulations in place that adequately respond to the specific realities of rural communities within the ecosystems concerned. Notwithstanding the current illegality of the trade, studies undertaken in different regions of the country clearly indicate the existence of trade networks and the importance of wild meat in the nutrition, culture and economy of urban and rural people. In a recent workshop organized in Leticia (Amazonas), Colombia has taken an unprecedented step in providing technical recommendations to adapt the national legal framework on wildmeat trade to the realities of rural communities in different eco-regions of the country. In particular, there is a tacit acknowledgement of the need for a flexible regulatory framework that allows an adaptive management and participatory process approach, at multiple scales, to develop management rules that are relevant and realistic in local contexts in order to enable improved sustainability and better livelihoods without pushing people into illegality. If translated into concrete policy changes, these recommendations will open a variety of innovative pathways for the sustainable use of wildlife, and create Colombian leadership in a problem that exists in many tropical forest countries around the world.

O65-03 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Developing locally adapted hunting management regulations for French Guiana

CÉCILE RICHARD-HANSEN[1], GUILLAUME LONGIN[2], PIERRE GRENAND[3], DAMIEN DAVY[4], RAPHAËLLE RINALDO[2], LAURENT GAILLARD[5], BERTRAND GOGUILLON[2]
[1]ONCFS/EcoFoG, DRE, 97310, Kourou, French Guiana
[2]Parc amazonien de Guyane, PNC, 97300, Cayenne, French Guiana
[3]IRD, OHM, 97300, Cayenne, French Guiana
[4]CNRS, USR 3456/OHM, 97300, Cayenne, French Guiana
[5]ONCFS, DIROM, 97310, Kourou, French Guiana

Although being a French overseas department, hunting regulations in French Guiana have never been really developed, recognizing the deep local specificities compared to mainland. However, a National Park now exists for 9 years, and the French Government presently shows its willingness to construct a new hunting law in the whole territory. Many hunting practices co-exist in French Guiana, from subsistence to sport and commercial use. Although indigenous people live in many places, they are not evenly integrated in the market economy, have different access to food stores and money, and also represent various traditional communities. Hunting is still a key part in these communities' lives, not only for subsistence, but also for cultural and social purposes. Present hunting regulations are based on protected or non-commercial species lists and some protected areas, but hunting is allowed in all the national park to "communities traditionally using natural resources". Particular regulations also exist in Amerindian and marroon collective lands. To accompany this evolution and monitor ecological and sociological changes, several programs were implemented, in various socio-ecological situations. Harvests and hunting practices were recorded during two intensive surveys in several villages, implemented 10 years apart in order to analyze geographical and temporal changes, and monitor the impact on wildlife through sustainability indices. First results reveal the differences between various hunting practices as between traditional communities. The impact on wildlife populations appears relatively geographically restricted in subsistence conditions and no strong defaunation probably exists at present time on a medium scale. However, the indicators point out some changes in the prey profiles and hunting yields, suggesting declining trends in some population status. A set of indicators is needed to properly analyze and understand these trends, and long-term monitoring have to be continued. The national park authorities organized meetings in several localities to present and discuss these results, and receive propositions and requests from local communities and their traditional authorities. The French government is presently examining how to take into account these local specificities, in the frame of a new national law and constitutional rights. Some pilot sites could be proposed to experimental co-management, with ecological and sociocultural adapted regulations.

O65-04 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Patterns of wild meat consumption in Central Africa

LAUREN COAD[1], DANIEL INGRAM[2], JORN SHARLEMANN[2]
[1]CIFOR, 16115, Bogor (Barat), Indonesia
[2]University of Sussex, School of Life Sciences, BN1 9QG, Brighton, UK

The harvest of wild animals from land and sea is a major source of protein for more than a billion of Earth's poorest inhabitants. Simultaneously, the unsustainable harvest of wild animals is one of the major threats to terrestrial biodiversity. Accurate global information on wild animal harvest and consumption is needed for reporting towards multiple international conventions and targets, including the Convention on Biological Diversity (CBD) Aichi Targets, the UN Sustainable Development Goals (SDGs) and the FAO Food Security Indicators. Further, regional and national data on wildlife offtake and use are needed to inform national wildlife and food security policies.
The OFFTAKE project (www.OFFTAKE.org) aims to investigate the off take of wild terrestrial species globally, collating and analysing datasets on wild meat harvest, consumption and sales from around the world. Here we present an analysis of wild meat consumption in Central Africa using the OFFTAKE database. We investigate regional patterns of wild meat consumption (e.g. amounts and species consumed), significant predictors of wild meat consumption, and how wild meat consumption varies with alternative sources of protein, such as domestic meats and fish. We discuss what these results might mean in terms of hunting sustainability, how these results might influence conservation and development policies in the region, and how the OFFTAKE database can be used to support regional and global conservation and development policy decision-making.

O65-05 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Legalized hunting on the Neotropical Island of Trinidad, West . Indies: A fifteen year study of hunting permits and harvest data

KIRSTEN M SILVIUS[1], TAKUYA IWAMURA[2], JOSÉ MV FRAGOSO[3], ERIC F LAMBIN[4], JEFFREY B LUZAR[5]
[1]Virginia Tech, FREC, 24061, Blacksburg, USA
[2]Tel Aviv University, Faculty of Life Sciences, 6997801, Tel Aviv, Israel
[3]California Academy of Sciences, Institute for Biodiversity Science and Sustainability, 94122, San Francisco, USA
[4]Stanford University, Woods Institute for the Environment, 94305, Palo Alto, USA
[5]Stanford University, Department of Anthropology, 94305, Palo Alto, USA

Hunting is mainly restricted to indigenous peoples in the Neotropics with the exception of Belize, Guyana, French Guyana and the Republic of Trinidad and Tobago. Of these countries which permit legalized hunting, hunter records and harvest data are sparse and almost nonexistent for entire countries. This paper presents the first analysis of hunting activities on the small island state of Trinidad, W. I. from 1997 to 2013, where an average of 30 000 hunters register annually on the island to hunt an area of 2000 km^2 during the five month hunting period. Of all the hunting permits sold over the 15 years, 52% were for hunting agouti (Dasyprocta leporina), 24% for lizards (Iguana iguana, caiman crocodiles and Tupinambis spp.), 7% for lappe/labba (Cuniculus paca), 5% for Red brocket deer (Mazama Americana) and 1% for collared peccary (Tayassu tajacu). Mean hunter harvests were 20 000 agoutis, 2 000 red brocket deer, 3 000 lappe/labba, 4 000 collared peccaries and 10 000 lizards over the 15 years investigated. Hunting permits and mandatory hunter return cards are employed by Trinidad, W. I. to capture the data; however, no data is verified by the regulatory authority. In addition, no population density investigations have ever been conducted on the island; hence an evaluation of hunting sustainability is difficult. Further research is needed to monitor hunting and hunter harvests on the island of Trinidad, W. I.

O65-06 – S65 *Subsistence hunting in the tropics: A coupled human natural system perspective*
Thursday 23 June / 10:00-12:00 – Antigone3

Interactions between institutional systems of hunting regulations in a Protected Area in the Brazilian Amazon

MARINA A. R. M. VIEIRA[1], GLENN H. SHEPARD[2], FÁBIO DE CASTRO[3]
[1]Instituto Piagaçu, Programa de Monitoramento e Uso de Fauna, 69060-095, Manaus, Brazil
[2]Centre for Latin American Research and Documentation, 1018, Amsterdam, The Netherlands
[3]Museu Paraense Emilio Goeldi, Antropologia, 66077-830, Belém, Brazil

The sustainability of tropical wildlife depends on institutional arrangements that effectively manage the access and use forms. However, different stakeholders constantly reinvent their strategies under different contexts, through a process of institutional blicolage. Therefore, rather than identifying points of compatibility and incompatibility between the local (informal hunting practices) and legal (hunting legislation) systems it is necessary to understand how these two regulation systems are shaped and transformed in a particular socioenvironmental context. According to the Brazilian legislation, hunting is allowed only in case of hunger. However, this tolerance is not clearly defined and no formal regulations for hunting practices are in place. As a result, public policies on Protected Areas in Brazil, which foresee the incorporation of wildlife management system, clashes with the stringent legal hunting restriction. The goal of this study is to evaluate the level of compatibility between legal and local hunting rules in the Sustainable Development Reserve Piagaçu-Purus (RDS-PP) in the central Amazonia, Brazil. We use the following data sources: secondary data (laws, RDS-PP Management Plan, meetings minutes); semi-structured (n=62) and structured (n=71) interviews with hunters, local leaders and members of the Reserve Management Council. We describe the local ruling system and analyze the cognitive consensus among the local actors. Hunters share a range of informal hunting rules from more symbolic (e.g., social taboos) to more consciously designed (e.g., rotation of hunting sites). Residents have understanding of the legal restrictions on hunting. There is consensus in the understanding of the local and legal rules, which represents an opportunity for building a management plan for hunting in the RDS-PP. The main point of disagreement is with regard to the commercialization of bush meat, banned by law, but part of the livelihood of the community residents. Because of the clash between laws regulating wildlife preservation and the local practices, hunters maintain their activity through a process of institutional bricolage, combining elements from symbolic, consciously designed local rules and legal regulations. Although this mechanism allows flexibility according to different socioenvironmental contexts, the contradictions regarding different ruling systems create uncertainty and disempowerment in the rights to hunt by the local population.

O66-01 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

REDD projects in theory and practice

SVEN WUNDER[1], CLAUDIO DE SASSI[2], AMY E. DUCHELLE[2], DAJU PRADNJA RESOSUDARMA[2], CHRISTY DESTA PRATAMA[2], ERIN SILLS[3], WILLIAM SUNDERLIN[2]
[1]CIFOR, Lima office, 12, Lima, Peru
[2]CIFOR, Headquarters, 16000, Bogor, Indonesia
[3]North Carolina State University, Dept. of Forestry and Environmental Resources, NC 27607, Raleigh, USA

Background: Reducing emissions from deforestation and forest degradation (REDD) represents an objective of mitigating forest carbon emissions, but has also in the early REDD days been promoted as an intervention model of multilevel conditional cash transfers known as payments for environmental services (PES). Conditionality at multiple levels, so goes the argument, would be a key feature that distinguishes REDD from earlier conservation action, promising greater chances for success. Yet, in practice only a minority of REDD projects has so far made extensive use of PES-like livelihood incentives being tied to land-use conditionality.
Method: Drawing on both CIRAD's ID-RECCO and CIFOR's GCS-M2 REDD project databases, we first use categorical principal component analysis to identify clusters of REDD projects, linking context variables to intervention mixes and designs. We then use logit regression to test specifically for what determines whether project implementers presently have chosen or not to de facto use PES-like transfers in their intervention mixes.
Results: We find that decisions to make use of conditional PES instruments vis-à-vis land stewards inside the project areas were significantly influenced by project sector lead (public vs. private NGO or for-profit), type and length of project financing, institutional/ land-tenure preconditions, project location (degree of market remoteness, including or not legally protected areas), and implementers' initially stated intentions whether to use PES.
Discussion: Our results suggest that both external and internal factors have a role to play in the choice of project proponents' choice of REDD implementation model. Any prospective post-Paris boost to the size and length of REDD financing horizons would likely also revive the original intentions of building on PES-like incentives as key components of REDD. However, lacking local preconditions for PES (tenure regularization, monitoring conditions) and project implementers' own mindset (greater belief in ICDP or regulatory approaches) are weighty internal factors that likely will co-determine whether or not REDD comes to fit a stylized theoretical model of a multi-level PES scheme.

O66-02 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

Assessing the effectiveness of subnational REDD+ initiatives by tree cover change analysis

ASTRID B. BOS[1], VALERIO AVITABILE[1], MARTIN HEROLD1, AMY E. DUCHELLE[2], SHIJO JOSEPH[2], CLAUDIO DE SASSI[2], WILLIAM D. SUNDERLIN[2], ERIN O. SILLS[3], ARILD ANGELSEN[4], SVEN WUNDER[5]
[1]Wageningen University, Laboratory of Geo-Information Science and Remote Sensing, 6700 AA, Wageningen, the Netherlands
[2]Center for International Forestry Research, Climate Change and Energy, 16000, Bogor, Indonesia
[3]North Carolina State University, Department of Forestry & Environmental Resources, 27695, Raleigh, United States of America
[4]Norwegian University of Life Sciences, School of Economics and Business, 1432, Aas, Norway
[5]Center for International Forestry Research, Forests and Human Well-Being, 1558, Lima, Peru

Background: Given the key role of forests in mitigating climate change, it becomes increasingly important to monitor the carbon effectiveness of policies and programmes for reducing emissions from deforestation and forest degradation (REDD+). Performance assessment is essential to check progress, verify accountability, and learn from REDD+ implementation in general, with important bearings on funding for REDD+ in the long term.
Methods: This study presents a new framework to assess the effectiveness of subnational REDD+ initiatives from 2000 to 2014 using tree cover change trajectories with and without REDD+ since its implementation. The change in annual tree cover loss both within and outside of initiative boundaries, before and after the start of interventions, is used as proxy for evaluating the carbon impact of 23 REDD+ initiatives in six different countries. The framework combines a traditional time series approach (i.e. measuring tree cover change over time) with a Before-After-Control-Intervention (BACI) approach across spatial scales. These scales include villages, initiatives, and subnational and national jurisdictions. A global dataset on tree cover and tree cover loss is used as input for consistent comparison across initiatives and countries.
Results: Our results indicate that the spatial definition of the "control" area has a large influence on the corresponding effectiveness assessment (BACI) ratio. Trends observed in the data occurring at multiple scales (e.g. temporary climatic effects such as dry years) need to be distinguished from trends happening in the area of interest exclusively (e.g. true REDD+ impact). At the same time, potentially negative REDD+ impacts (i.e. leakage) may be revealed occurring outside the intervention areas.
Discussion & conclusion: We suggest that the performance of REDD+ initiatives should be assessed considering both control and intervention areas and multiple scales of analysis to provide a more complete understanding of the changes in tree cover occurring in the area of interest. This study contributes to carbon measurement, reporting and verification (MRV) by offering a framework, which includes contextual information on tree cover changes in areas where REDD+ has been implemented on the ground.

O66-03 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

Are households' forest clearing affected by REDD+?

STIBNIATI ATMADJA[1], ARILD ANGELSEN[2], CLAUDIO DE SASSI[1], DAJU RESOSUDARMO[1], DANIEL SURYADARMA[3], MELLA KOMALASARI[1], DESTA PRATAMA[1], DEMITRIUS KWEKA[4], DAWN WARD[4]
[1]CIFOR, Forests and Livelihoods, 16115, Bogor, Indonesia
[2]University of Life Sciences (UMB), School of Economics and Business, 1432, As, Norway
[3]CIFOR, Monitoring, Evaluation and Impact Assessment, 16115, Bogor, Indonesia

Background: In this paper, we assess whether REDD+ interventions have had an impact on forest clearing by rural household, and the local contexts that have influenced any change in behavior. Although clearing by smallholders is increasingly dominated by large scale commercial actors, it still plays a non-negligible role in global greenhouse gas emissions. Reducing forest clearing by households was the main rationale for sub-national initiatives to reduce emissions from forests and forest degradation (REDD+). However, REDD+ interventions to reduce local forest conversion and use could negatively affect the livelihoods among communities.
Data and Method: Data was collected from 22 REDD+ initiatives in six countries in two periods, between 2010 and 2014. We compare forest clearing among households in control and intervention villages (i.e., without and with REDD+ intervention), before and after REDD+ interventions took place, to evaluate the impact of REDD+ on forest clearing. Further analysis will apply propensity matching and other econometric methods to refine results and identify household, environmental/context and project characteristics that determine the effect of REDD+ interventions on household forest clearing.
Result: In our last data collection, sampled households in Brazil cleared the most (mean = 1.45ha/household), while those in Tanzania cleared the least (mean 0.01 ha/household). In general there were no statistically significant changes in the areas cleared by sampled households in control and intervention villages, across the two periods. An exception are households in Cameroon, where on average forest clearing declined more in control villages (-0.85ha/household) compared to intervention villages (-0.38 ha/household). We note that during the baseline period, the average forest clearing in intervention villages was almost half (1.1.5 ha/household) that of control villages (2.02 ha/household).
Discussion: These preliminary results show REDD+ has no general impact on household forest clearing. In some cases, areas without REDD+ experienced more reductions in forest clearing. With further analysis in the following months, our study can provide more explanation for these outcomes. This study contributes to what is currently a very small body of empirically-based evidence of the effectiveness of REDD+ intervention in influencing household-level behavior related to forest clearing.

O66-04 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

The effectiveness of REDD+ initiatives in changing local people's emission-generating activities: household perspectives from Africa, Asia, and Latin America

IDA AJU PRADNJA RESOSUDARMO, MELLA KOMALASARI, CHRISTY DESTA PRATAMA, STIBNIATI ATMADJA, WILLIAM SUNDERLIN
Center for International Forestry Research, Forests and Human Well being, 16115, Bogor, Indonesia

REDD+ effectiveness is commonly assessed through recorded emission reductions within a given period and area. This paper proposes a novel approach to evaluate REDD+ effectiveness, where greenhouse gas (GHG) emission reductions are determined through self-reporting of changes in land use activities and natural resource management that generate these emissions. We ask: 1) Do REDD+ interventions affect local land use and natural resource management? How do REDD+ interventions affect local people's land use and natural resource management? We interviewed over 2,000 households in 87 villages at 22 sites in Cameroon, Tanzania, Indonesia, Vietnam, Brazil and Peru in 2013 and 2014. We asked these households to report whether each specific intervention induced change in their land use practices. We found that 70 percent of households participated in at least one type of intervention; a single household could be involved in a variety of interventions. About two-thirds of households who received interventions reported that they changed at least one of their land use practices, mostly shifting to activities associated with lower GHG emissions. However, about half of households who received interventions also reported that they did not change at least one type of their land use activities. The extent to which REDD+ interventions change local people's land use behavior vary and are likely associated with the types and characteristics of interventions and contexts.

O66-05 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

Who will bear the cost of REDD+? Evidence from the incidence of implementation and opportunity costs in subnational REDD+ initiatives

CECILIA LUTTRELL[1], ERIN SILLS[2], RIZA ARYANI[3], DESITA ANDINI[3], MARIA FEBE EVINKE[3]
[1]CIFOR, Livelihoods, 16115, Bogor, Indonesia
[2]NCSU, Forestry & Environmental Resources, 27695, Raleigh, USA
[3]CIFOR, Livelihoods, 16115, Bogor, Indonesia

REDD+ is based on the reasoning that reducing forest carbon emissions is less expensive than reducing carbon emissions from other sectors. Payments from other sectors and developed countries are expected not only to cover the costs of reducing deforestation, but also generate a surplus that can be shared through a benefit-distribution system. However, concerns have been raised about whether costs will be fully covered by these payments, or whether some of the cost will be borne by stakeholders in REDD+ countries. Two of the greatest concerns are that: (i) the start-up costs of REDD+ will be much higher than generally recognized and will fall on host country institutions that will not be compensated for these costs; and (ii) that disadvantaged groups, including smallholders and those without legally recognized claims to forest land and resources, will not be fully compensated for the opportunity costs they bear.
Based on the experiences of 22 subnational REDD+ initiatives in five countries, we examine the degree to which these concerns about REDD+ are playing out in the incidence of implementation costs in the start-up phase, and in the expected incidence of opportunity costs. Specifically, we examine the types of institutions that share the burden of implementing REDD+, and the types of stakeholders that are expected to bear the greatest opportunity costs, considering how these vary according to: (i) the primary objective of the initiative; (ii) the primary source of start-up funding; (iii) the approach to forest use and management; and (iv) the intention and realization of sales in the voluntary carbon offset market.
Our findings demonstrate the wide range of stakeholders that must be considered in any benefit sharing system that aims to compensate for the full costs of REDD+, reveal patterns in how the incidence of costs varies across types of REDD+ initiatives, and identify some basis for concerns that stakeholders in REDD+ countries will end up bearing the costs of REDD+. The first step towards mitigating concerns regarding the costs of REDD+ is to make the distribution of those costs transparent, thereby identifying the full set of stakeholders that should be considered in future research, consulted about benefit-sharing systems, and brought to the table for negotiations. Our study contributes to this by characterizing the institutions and stakeholders that bear the costs of different types of subnational REDD+ initiatives.

O66-06 – S66 *Evaluating the impacts of redd+ interventions on forests and people*
Thursday 23 June / 14:30-17:00 – Antigone3

A pan-tropical assessment of REDD+ socioeconomic impacts on smallholders

DE SASSI CLAUDIO[1], AURIA ANDINA[1], AMY ICKOWITZ[1], DEMETRIUS KWEKA[2], ERIN SILLS[3],
PAMELA JAGGER[4], SVEN WUNDER[5], WILLIAM SUNDERLIN[1]
[1]CIFOR, Forest and Livelihoods, 16115, Bogor, Indonesia
[2]TBD, TBD, TBD, Dar-es-Salaam, Tanzania
[3]North Carolina State University, Forestry & Environmental Resources, NC 27695, Raleigh, United States
[4]University of North Carolina, Public Policy, NC 27599, Chapel Hill, United States
[5]CIFOR, Forest and Livelihoods, C/O CIP, Lima, Peru

Background: Reducing carbon emissions through avoided deforestation and forest degradation and enhancement of carbon stocks (REDD+) seeks to compensate smallholder farmers for avoided emissions from forests, and thus provide a solution for climate change mitigation while sustaining rural livelihoods. A key element in the objectives and integrity of REDD+ is that compensation must be fair and equitable among stakeholders. After several years of experience with subnational REDD+, it remains unclear to what extent livelihoods are protected or even improved, in a manner that is equitable within villages and communities.
Methods: CIFOR's Global Comparative Study on REDD+ studied implementation of subnational REDD+ schemes in six countries. For this paper, we draw on village and household-level surveys from 17 sites, 129 villages, and nearly 4,000 households, at two points in time, using a robust Before-After, Control-Intervention (BACI) design for impact evaluation. We apply matching techniques and multilevel regressions to examine changes in income over time (before and after REDD+) for different wealth groups, and examine how REDD+ impacts, if any, are distributed.
Results: We show that average household income has increased over time in sites in two countries, decreased in one, and remained stable in three others. Further, we show that estimated opportunity costs vary by order of magnitudes between the poorest and the richest households. Embedded into these site-specific dynamics, we observe both positive and negative impacts from REDD+ interventions in six study sites, and detected no effect in eleven. Preliminary results suggest that in one site, REDD+ had an inequitable effect by reducing the income of poorer households.
Discussion: The risks of adverse socioeconomic impacts of REDD+ have been debated intensively, yet based on little hard empirical evidence. Our results can thus shed further light on this question. We didn't detect effects on income at most sites, in some they were positive, and only significantly negative impacts could be observed. This underlines that REDD+ is not a panacea for promoting local economic development, yet on the other hand the risks of overall income losses would, based on our cases, seem to remain limited. Through analysis of site contexts we finally provide some pointers as to which design features in REDD+ interventions could provide further safeguards against welfare losses at the local level.

O67-01 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Using the knowledge of endemic grass species to puzzle out ancient Madagascar

MARIA S.VORONTSOVA[1], HANS PETER LINDER2, JAN HACKEL[3], GUILLAUME BESNARD[3]
[1]Comparative Plant and Fungal Biology, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK, corresponding author
[2]Institute of Systematic Botany, University of Zurich, Zollikerstrasse 107, Zurich 8008, Switzerland
[3]CNRS-UPS-ENFA, UMR5174, EDB (Laboratoire Evolution et Diversite Biologique), Universite Paul Sabatier, 118 route de Narbonne, 31062 Toulouse, France

Background: The dominant narrative regarding human arrival in Madagascar has long stated that people arrived 2,500 years ago to a largely forested island, with anthropogenic destruction responsible for the minimum 65% of Madagascar's area now covered in grasslands and savannas. Scarcity of lake bed deposits have made paleoenvironmental reconstruction difficult and the diversity of ecosystem histories across the island have complicated the debate. One piece of the puzzle regarding Madagascar's grasslands remains missing: the grasses themselves have never been fully documented or considered in an ecological perspective.
Method: Herbarium specimens of Malagasy grasses (family Poaceae) have been studied, taxonomic revisions produced, and new species described during the six years of this project. Regular field work has targeted locations of poorly known endemic grasses and species knowledge has been built up throughout the island. Phylogenetic trees were built and evolutionary reconstruction carried out in order to examine the instances of Poaceae colonisations of Madagascar. Data on species composition, phylogenetic diversity, and disturbance levels has been gathered at 60 sites.
Result: At best current estimate 217 of Madagascar's 541 grass species are endemic, a level of endemicity in line with the grass floras of other subtropical islands. Many of the endemic species are restricted to isolated locations within Madagascar and others show a regional flora. Several lineages unique to Madagascar use the C4 photosynthetic system and are likely to have evolved in open canopy areas. Phylogenetic diversity within Poaceae decreases in areas with strong physical disturbance but no significant change with frequent grazing is recorded.
Discussion: Madagascar is home to an ancient grass flora which behaves like a natural species assemblage. This indicates that pre-human Madagascar included at least some tropical grassy biomes. Where were these located and how can they be distinguished from anthropogenic pasture landscapes? These are the questions the project will tackle next.

O67-02 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Woody encroachment over 70 years in South African savannas: overgrazing, global change or extinction aftershock?

NICOLA STEVENS[1], BAREND ERASMUS[2], SALLY ARCHIBALD[3], WILLIAM BOND[4]
[1]University of Stellenbosch, Department of Zoology and Botany, 7602, Stellenbosch, South Africa
[2]University of the Witwatersrand, Global Change and Sustainability Research Institute, 2050, Johannesburg, South Africa
[3]University of the Witwatersrand, Animal, Plant and Environmental Sciences, 2050, Johannesburg, South Africa
[4]South African Environmental Observation Network, National Office, 7600, Cape Town, South Africa

Background: Woody encroachment in "open" biomes like grasslands and savannas is occurring globally. Both local and global drivers, including elevated CO2, have been implicated in these increases. The relative importance of different processes is unresolved as there are few multi-site, multi land-use, evaluations of woody plant encroachment.
Methods: We measured 70 years of woody cover changes over a 1020km^2 area covering four land uses (commercial ranching, conservation with elephants, conservation without elephants and communal rangelands) across a rainfall gradient in South African savannas. Different directions of woody cover change would be expected for each different landuse, unless a global factor is causing the increases. Woody cover change was measured between 1940 and 2010 using the aerial photo record. Detection of woody cover from each aerial photograph was automated using eCognitions' Object based image analysis (OBIA).
Results: Woody cover doubled in all land uses across the rainfall gradient, except in conservation areas with elephants in low rainfall savannas. Woody cover in 2010 in low rainfall savannas frequently exceeded the maximum woody cover threshold predicted for African savannas.
Conclusion: The results indicate that a global factor, of which elevated CO2 is the likely candidate, may be driving encroachment. Elephants in low rainfall savannas prevent encroachment and localized megafaunal extinction is a probable additional cause of encroachment.

O67-03 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Competing Consumers: contrasting the patterns and impacts of fire and herbivory

SALLY ARCHIBALD, GARETH HEMPSON
University of the Witwatersrand, Centre for African Ecology, School of Animal Plant and Environmental Sciences, 2050, Johannesburg, South Africa

Fire and herbivory are the two dominant consumers of above-ground biomass globally, removing almost all aboveground NPP in some ecosystems. They have contrasting impacts as they differ in terms of selectivity and temporal occurrence. Here we integrate continental-scale data on fire and herbivory in Africa to explore i) how environmental drivers constrain these two consumers, and ii) the degree to which each consumer affects the other. Environments conducive to mammalian herbivory are not necessarily the same as those conducive to fire, although their spheres of influence do overlap– especially in grassy ecosystems which are known for their frequent fires and abundance of large mammalian herbivores. Despite this most parts of Africa currently either have high herbivory or high fire, seldom both. Interactions between fire and herbivory can be competitive, facultative or antagonistic, and we explore this with reference to the potential for alternative ecosystem states. Although fire removes orders of magnitude more biomass than herbivory their methane emissions are very similar, and in the past herbivores probably emitted more methane than fire. We contrast the type of herbivory and fire in different ecosystems to define "consumer-realms".

O67-04 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Changes in African herbivore communities and consequences for grassy ecosystems

GARETH HEMPSON, SALLY ARCHIBALD
University of the Witwatersrand, Centre for African Ecology, School of Animal, Plant and Environmental Sciences, 2050, Johannesburg, South Africa

Background. Natural populations of large mammal herbivores have been severely depleted across the globe, with profound consequences for ecological dynamics. Grassy ecosystems are particularly prone to the consumptive effects of large mammal herbivores, where they can act as ecosystem engineers by influencing fire prevalence, tree-grass competition and nutrient cycling. Livestock have replaced natural herbivore populations across vast areas, and thus may help to restore lost ecological function to ecosystems. However, critical to this assessment is the extent of change in both the biomass and functional composition of herbivore communities.
Method. We explore how the abundance and composition of African herbivore communities has changed over the last ~1000 years, using species-level reconstructions of historical and current herbivore community composition. Focusing on grassy ecosystems, we relate these changes to continental-scale patterns of fire prevalence and the functional type composition of grassland communities.
Results. Herbivore biomass losses have been most pronounced in mesic grassy ecosystems, with drier regions experiencing greater turnover in functional composition. Shifts in grazer biomass appear to have reduced fire prevalence over much of the continent, and highlight areas prone to degradation resulting from reduced vegetation cover and shifts in grass community composition under frequent grazing.
Discussion. Quantifying change in African herbivore communities provides significant context for understanding important processes such as woody cover losses and bush encroachment in grassy ecosystems. Furthermore, our enhanced understanding of shifts in consumer dominance allows for an assessment of the risk associated with grazer and fire management practices under different environmental conditions across the continent.

O67-05 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Many shades of green: the dynamic tropical forest-savanna transitions

IMMA OLIVERAS[1], YADVINDER MALHI[2], AGNE GVOZDEVAITE[3], ANABELLE CARDOSO[4], JOSÉ MEDINA-VEGA[5], THERESA PREPAH[7], STEPHEN ADU-BREDU[8], ELMAR VEENENDAAL[9], BEATRIZ SCHWANTES-MARIMON[10], GREGORY GOLDSMITH[6], BEN HUR MARIMON-JUNIOR[11], ALEXANDER SHENKING[12]
[1]University of Oxford, School of Geography and the Environment, OX13QY, Oxford, UK
[2]University of Oxford, School of Geography and the Environment, OX13QY, Oxford, UK
[3]University of Oxford, School of Geography and the Environment, OX13QY, Oxford, UK
[4]University of Oxford, School of Geography and the Environment, OX13QY, Oxford, UK
[5]Wageningen UR, Forest Ecology and Management, 6708PB, Wageningen, Netherlands
[6]FORIG, CSIR, 000, Kumasi, Ghana
[7]Paul Scherrer Institute, Ecosystems Fluxes Group, 5232, Zurich, Switzerland
[8]FORIG, CSIR, 000, Kumasi, Ghana(9) Wageningen University, Plant Ecology and Nature Conservation, 6708PB, Wageningen, Netherlands
[10]UNEMAT, Ecology and Conservation, 25001, Nova Xavantina, Brazil
[11]UNEMAT, Ecology and Conservation, 25001, Nova Xavantina, Brazil
[12]University of Oxford, School of Geography and the Environment, OX13QY, Oxford, UK

Background. The forest-savanna transition is the most widespread ecotone in tropical areas, separating two of the most productive terrestrial ecosystems. The frequently abrupt nature of this transition suggests that forest and savanna can exist as alternative stable states, but the relative contributions of the main biotic and abiotic drivers and their interactions are yet not fully understood.
Methods. We review and illustrate with examples both from the literature as well as arising from our own research the current understanding of the factors that shape this transition, and how it may change under various drivers of local or global change.
Results and Discussion. At broadest scales the location of the transition is shaped by water availability, mediated strongly at local scales by fire regimes, herbivory pressure and spatial variation in soil properties. These drivers interplay with a wide range of ecological processes and attributes at the global, continental, regional and local scales. The evolutionary history of the biotic and abiotic drivers and processes plays an important role on the current distributions of these transitions as well as in their species composition and ecosystem functioning. This ecotone can be sensitive to shifts in climate and other driving factors, but is also potentially stabilized by negative feedback processes. There is abundant evidence that these transitions are shifting under contemporary global and local change, but the direction of shift varies according to region. However, it still remains uncertain how these transitions will respond to rapid and multi-faceted ongoing current changes, and how increasing human influence will interact with these shifts.

O67-06 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Redefining the historical forest extent in Sub-Saharan Africa: implications for grass-dominated biomes conservation.

JULIE ALEMAN, CARLA STAVER
Yale University, Ecology and Evolutionary Biology, 06511, New Haven, USA

Background: Savannas and grasslands constitute around 40% of the land surface worldwide. While they sustain crucial ecosystem services, they, however, have attracted little conservation interest compared to tropical forests. This is essentially because they have long been considered anthropogenic artifacts and degraded lands as compared to their "pristine" forest neighbor. To support this idea, many studies used alarming deforestation rates since the beginning of the twentieth century: more than a half of the African tropical forest would have been deforested.
These concerns about deforestation have led to the development of reforestation strategies to mitigate global change and sequester carbon. Most of the targeted areas, however, correspond to mesic savannas, especially those directly bordering forests. In addition, these same areas have also been identified as very suitable for biofuel production in the most optimistic RCP scenario.
Method: Our goal is to redefine the historical (~1900) forest extent in Sub-Saharan Africa to provide better estimates of historical deforestation rates and to identify areas where grass-dominated biomes are not the results of industrial deforestation. We thus used three of the most cited estimates of past forest extent: White's map of vegetation in Africa, the remaining forest of the world from WWF assessment and a Potential Natural Vegetation map. We then performed a meta-analysis of all available vegetation data dated ~1900: sedimentary pollen sites from the African Pollen Database, phytolith sedimentary data, δ13C of paleosols and vegetation description from essays and documents.
For each individual site, a main vegetation type (forest or grass-dominated) was assigned as well as the distance from the corresponding type in each map. Based on the distance estimates we adjusted the location of the past forest-savanna boundary and computed new estimates of deforestation.
Results and discussion: Our preliminary results show that past estimates of deforestation have been largely overestimated, especially in West and Central Africa. Most of areas identified as forests were actually savannas and some of them even had persisted for millennia. We thus suggest that these areas should be removed from the reforestation plans of the World Resources Institute Atlas of Forest and Landscape Restoration Opportunities. Our new maps of the historical forest extents have thus strong implications for the management of grass-dominated biomes.

O67-07 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Reconciling agriculture, carbon, and biodiversity in a savanna transformation frontier

LYNDON ESTES[1], TIM SEARCHINGER[2], MARCUS SPIEGEL[1], TIAN DI[1], SICHINGA STALIN[3], MWALE MOSES[3], KEHOE LAURA[4], KUEMMERLE TOBIAS[4], BERVEN ALISTAIR[1], CHANEY NATHANIEL[1], SHEFFIELD JUSTIN[1], WOOD ERIC[1], CAYLOR KELLY[1]
[1]Princeton University, Civil and Environmental Engineering, 08544, Princeton, NJ
[2]Princeton University, Woodrow Wilson School, 08544, Princeton, NJ
[3]Government of Zambia, Zambia Agricultural Research Institute, NA, Chilanga, Zambia
[4]Humboldt University, Geography, 10099, Berlin, Germany

Background: Rapidly rising populations and likely increases in incomes in sub-Saharan Africa make tens of millions of hectares of cropland expansion nearly inevitable, even with large increases in crop yields. Much of that expansion is likely to occur in higher rainfall savannas, at substantial costs to biodiversity and carbon storage. Zambia presents an acute example of this challenge, with an expected tripling of population by 2050, good agronomic potential to expand maize and soybean production, and large swaths of relatively undisturbed Miombo woodland and associated habitat types of high value to mammals and birds.
Methods: Here we present a new model designed to explore the potential to target agricultural expansion in ways that achieve quantitatively optimal trade-offs among competing economic and environmental priorities, based on minimizing the cost in four objectives: land area required for conversion (the reciprocal of yield potential); carbon loss, biodiversity loss, and transportation costs. To allow different interests to find potential compromises, the model allows users to apply varying weights to examine the effects of their subjective preferences on the spatial allocation of new croplands and its costs.
Results: We find that small compromises by the objective to target expansion in the highest yielding areas permit large savings in transportation costs, and the carbon and biodiversity impacts resulting from savanna conversion. For example, transferring just 30% of weight from a yield maximizing objective equally between carbon and biodiversity protection objectives would increase total cropland area by just 2.7%, but result in avoided cost of 27%-47% for the carbon, biodiversity, and transportation cost objectives. Compromise solutions tend to focus agricultural expansion along existing transportation corridors and in already disturbed areas.
Discussion: Used appropriately, this type of model could offer a practical means by which countries could explore agricultural expansion alternatives and target transportation investments and land use policies to achieve production targets while helping to conserve savannas. The need for such approaches will grow as savannas and other grassy biomes come under increasing agricultural development pressure, which may be further exacerbated as an indirect result of the laudable and necessary efforts to conserve tropical forests.

O67-08 – S67 *Tropical grassy biomes. Part 2. Reconciling ecology, human use and conservation*
Thursday 23 June / 08:00-10:00 – Rondelet

Population Dynamics of three rodent species in a Flooded Neotropical Savanna

LANA CANDELÁRIA, LÚCIA MATEUS, VIVIANE LAYME
UFMT, Botanica e Ecologia, 78060-900, Cuiabá, Brasil

Pantanal is the largest flooded savanna that occur in South America and is one of the world's most productive habitats, although have low endemism. In the biome, many rodent species use exclusively open habitats that remain flooded for several months in each year. Here, we evaluate the effect of seasonal flooding on the population dynamics of three rodent species of the Pantanal (Necromys lasiurus and Calomys callosus, exclusivelly terrestrial species, and Holochilus sciureus, semi-aquatic specie). For this, we followed the populations in 10 grids during dry season over six years and we used mark-recapture methods to estimate population size. For each year, the intensity of the flood was obtained by fluviometric quota of the Cuiaba river. We verified the effect of intensity of flooding on the rodent populations using general linear models. In addition, we modeled the dynamics of occupation of the rodent species in the region, including the flood in the local extinction and colonization estimates. During the study, all populations fluctuated extensely through the years and of the sites and, one of the terrestrial species (N. lasiurus) was not registrated along two consecutive years. The fluviometric quota ranged from 323.65 to 463.20 cm. The populations of C. callosus and N. lasiurus had a negative relationship with the intensity of the flood, while the population size of the H. sciureus was not directly affect by flood. However, the intensity of flood seem affect the probability of extinction of the H. sciureus. We conclude that the increased in flood intensity can negatively affect rodent populations, specially of terrestrial species. However, these responses can not be generalized for all community. The flood regime seems to be the key to the abundance of vertebrates in the Pantanal. Thus, changes in the hidrology should affect the fauna and makes the biome be vulnerable to changes in the land use.

O68-01 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Is forest fragmentation driving functional homogenization in remaining tropical forest fragments?

JENNY ZAMBRANO[1], NOELLE BECKMAN[1], CLAIRE FORTUNEL[2], CAROL GARZON[3]
[1]University of Maryland, SESYNC, 21401, Annapolis, USA
[2]University of California Los Angeles, Department of Ecology and Evolutionary Biology, 90095, Los Angeles, USA
[3]Université de Picardie Jules Verne, Ecologie et dynamique des systèmes anthropisés, 80037, Amiens, France

The fragmentation of forests resulting from deforestation is one of the leading causes of global biodiversity loss. In addition, changes in biotic and abiotic conditions in remaining forest fragments may filter for plant species with certain trait combinations, thereby resulting in functional homogenization in these fragments. Recent studies on tropical forest fragments have shown reduction in the frequency of particular plant functional traits and in some cases complete loss of a plant functional trait. This loss of functional diversity usually translated into the proliferation of pioneer plant species at the expense of late-successional plant species. Most studies have found that functional homogenization was strongly driven by the conditions along the edges created by fragmentation. Old-growth species are particularly vulnerable to the detrimental effects of elevated radiation, temperature and wind turbulence that characterize the edge of forest fragments.
However, efforts to generalize the magnitude of functional homogenization of tropical forest fragments and to identify its drivers have been hampered by the lack of consensus on terminologies and methods to measure functional diversity. In particular, very few studies to date have incorporated all components of functional diversity (functional richness, functional evenness and functional divergence). Additionally, there is little consensus concerning the choice of traits. For example, several studies have used regeneration strategy (pioneer vs. shade-tolerant) and life form (understory, canopy or emergent species) to describe shifts in functional traits in forest fragments, but this is misleading as these broad categories prevent disentangling underlying mechanisms of functional homogenization. The goal of this study is to review previous findings on functional homogenization in tropical forest fragments and provide a roadmap to improve the study of functional homogenization in fragmented landscapes across regions. A clear understanding of the effects of forest fragmentation on functional diversity will allow improving predictions of the resilience and resistance of fragmented plant communities under global change.

O68-02 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Reorganization of tropical tree assemblages in human-modified landscapes: patterns, driving forces and potential impacts

MARCELO TABARELLI
Universidade Federal de Pernambuco, Botânica, 50670901, Recife, Brazil

Tropical forests continue to be exposed to a myriad of human-related disturbances, including land-use and climate changes, with impacts on biodiversity persistence and provision of ecological services. Future demands for agricultural lands tend to aggravate this trend. Particularly in the neotropics, empirical evidence suggests that tropical tree assemblages can be profoundly altered at multiple spatial scales, although community-level attributes differ in terms of sensitivity to disturbances. I refer to reductions in species richness and diversity in parallel to directional changes in taxonomic and functional composition. In fact, a substantial portion of the old-growth flora tends to be replaced by few stress-tolerant taxa. Such a winner-loser replacement promoted by native species results in both taxonomic and functional homogenization, with cascade effects on the assemblages of plant attendants (e.g. pollinators, seed dispersers and herbivores). Several disturbance-sensitive traits are not phylogenetically clustered, rendering community-level phylogenetic attributes to be more resistant to human disturbances. Moreover, several ecological losers are directly involved in key ecosystems services and functions, such as those provided by large tree species. Most of these changes in the nature of tree assemblages are driven by a combination of edge-effects, seed dispersal limitation and population depletion due to collection of forest products. Habitat loss and fragmentation, chronicle disturbances and climate change can intensity some environmental changes experienced by human-modified landscapes (e.g. habitat desiccation), favoring the same ecological groups, such as fast-growing and successional tree species. This may intensify the proliferation of winner taxa and biotic homogenization. Finally, tropical forests and their vegetation types exhibit intrinsic differences relative to both the direction and magnitude of responses to changes in landscape. Whatever the differences in terms of forest resilience, large-scaled conservation strategies should consider the implementation of 'biodiversity-friendly landscapes' in order to safeguard the tropical legacy.

O68-03 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Does habitat fragmentation dampen or amplify demographic heterogeneity?

BRUNA EMILIO
University of Florida, Department of Wildlife Ecology and Conservation & Center for Latin American Studies, 32611, Gainesville, USA

Background: The local extinction of species from fragments appears common. Those species that do persist in fragments often have similar life-histories, resulting in functionally homogenous ecological communities. However, the population-level demographic responses of these species to biotic and abiotic conditions in fragments remain poorly understood. Plant demography is spatially and temporally variable as a result of local environmental heterogeneity. This demographic variation is important because it permits populations to respond to changing local environmental conditions. I propose that the ecological changes associated with habitat fragmentation drive another important form of homogeneity – the dampening of demographic variation – that can be observed both within- and between populations. While within-population demographic variation frequently receives the bulk of theoretical and empirical attention in demographic studies because of it's central role in population persistence, inter-population variation is a key factors promoting the persistence of species across a landscape.
Methods: I first show the different ways in which demographic homogeneity can be quantified and put forward potential ecological and evolutionary consequences of dampened demographic variability. I then test these hypothesized mechanisms using Integral Projection Models (IPMs) parameterized with demographic data on an understory herb (Heliconia acuminata, Heliconiaceae). These data were collected in the experimentally fragmented landscape of Brazil's Biological Dynamics of Forest Fragments Project.
Results and Conclusions: My results indicate that demographic variation may be stripped away in small forest fragments, though the mechanisms responsible for this are unclear. This has important consequences for population persistence across fragmented landscapes - if large-scale ecological phenomena detrimentally affect different populations in similar ways, this increases the probability for simultaneous declines in abundance throughout a landscape. Future population-level studies of plants in fragmented landscapes should look beyond summary statistics, such as lambda to how fragmentation may influence landscape-wide patterns of variation in demography.

O68-04 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Persistence of forest tree species in human-modified landscapes of central Panama

DAISY DENT[1], ROLANDO PEREZ[2], SALOMON AGUILAR[2], RICK CONDIT[2]
[1]University of Stirling, Biological and Environmental Sciences, FK9 4LA, Stirling, UK
[2]Smithsonian Tropical Research Institute, Center for Tropical Forest Science, 0843-03092, Panama, Panama

Background: Old-growth forests continue to be cut and degraded, and the human-modified landscapes that result from these processes are a mosaic of old-growth forest fragments, degraded forest, regenerating forest and agricultural land. Human-modified landscapes cover increasingly large areas across the tropics and yet only 9.8% of the tropical forest biome is strictly protected. Therefore, the long-term conservation of tropical forest biodiversity is dependent on human modified landscapes to maintain viable populations of tropical forest species. However, studies that investigate species diversity and composition across diverse tropical landscapes are lacking, and the factors that determine the presence of old-growth forest species in these landscapes remain poorly understood.
Methods: To investigate the species richness and composition of woody species across a human-modified agricultural landscape in central Panama, we conducted inventory surveys of all woody shrubs and trees at 26 sites. These sites included living fences, remnant forest patches and regenerating forest patches. Specifically we investigate 1) how species composition compares with that of neighboring old-growth forest within the Barro Colorado Nature Monument, and 2) whether species characteristics or life-history traits can explain abundance across the landscape.
Results/ Discussion: A total of 454 species were found across the landscape, with 258, 365 and 318 species present in living fences, remnant forest and regenerating forest patches respectively. Of the 303 species present in Barro Colorado 50-ha old-growth forest plot, 244 (81%) were present in the landscape. Species overlap with old-growth forest was greatest in remnant forest (72%) and lowest in living fences (47%). The most abundant species across the landscape (i.e. those present in the greatest number of sites) tended to have low shade-tolerance and/or human-uses (e.g., fruit trees, or trees suitable for animal fodder or fencing). In contrast, species present in old-growth forest but absent from the agricultural landscape tended to have large, animal dispersed seeds. These species will be most threatened by agricultural expansion and loss of old-growth forest. Our data indicate that human-modified landscapes may provide suitable habitat for many forest species, but detailed studies are required to determine the mechanisms that maintain species populations across these landscapes.

O68-05 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Roads, fragmentation and the functional composition of southwestern Amazonian forests

CHRISTOPHER BARALOTO[1], GALIA SELAYA[2], MATTHEW MARSIK[3], STEPHEN PERZ[4]
[1]Florida International University, International Center for Tropical Botany, 33133, Miami, USA
[2]University of Florida, Department of Agricultural and Biological Engineering, 32611, Gainesville, USA
[3]University of Florida, LUECI, 32611, Gainesville, USA
[4]University of Florida, Department of Sociology and Criminology & Law, 32611, Gainesville, USA

Functional diversity and functional composition of tropical plant communities can mitigate both the impacts of land use changes and their consequences for ecosystem services such as carbon storage. Roads can impact functional composition both directly via deforestation, and indirectly due to either increased resource exploitation associated with greater access, and/or to fragmentation and edge effects. In the southwestern Amazon, recent road construction and road paving has resulted in a landscape that includes gradients of both forest fragmentation and resource exploitation including logging. In this presentation we integrate GIS analyses of fragmentation and road networks, together with more than 300 vegetation plots, across the tri-national "MAP" frontier, so named after the three states that constitute this region: Madre de Dios (Peru), Acre (Brazil) and Pando (Bolivia). We will address the extent to which road infrastructure is associated with functional homogenization in these forests due to increased access from local settlements versus fragmentation effects in areas farther from human settlements.

O68-06 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Matrix type influences tree community assemblages along tropical dry forest edges

JULIETA BENITEZ-MALVIDO[1], JULIO CESAR GALLARDO-VASQUEZ[1], MARIANA Y. ÁLVAREZ-AÑORVE[2], LUIS D. ÁVILA-CABADILLA[2]
[1]UNAM, IIES, 58190, Morelia, Mexico
[2]UNAM, ENES, 58190, Morelia, Mexico

Edges effects have strong negative consequences for the functioning of tropical ecosystems, however edge effects on tropical dry forest (TDF) tree communities have been barely documented. In the TDF of Chamela, Mexico, we investigated the phylogenetic composition and structure of tree assemblages abutting different matrices: (i) disturbed vegetation with cattle, (ii) pastures with cattle and (iii) pastures without cattle. In addition, we sampled conserved forest interiors. All edge types showed similar tree density, basal area and diversity to interior forests, but differed significantly in tree species composition. A nonmetric multidimensional scaling ordination showed that the presence of cattle has a stronger influence on species composition than did the vegetation structure of the matrix, where tree assemblages abutting matrices with cattle presenting the lower scores in the ordination. The phylogenetic composition of tree assemblages followed the same pattern. All habitats showed random phylogenetic structures, suggesting that tree communities are assembled mainly by stochastic processes. Long-lived species persisting after edge creation could have important implications in the phylogenetic structure of tree assemblages. Edge creation exerts a stronger influence on TDF vegetation pathways than previously documented, leading to new ecological tree communities. The use of phylogenetic analysis, however, may be needed for such changes to be detected.

O68-07 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Erosion in functional and phylogenetic diversity of insular tropical tree assemblages

MAÍRA BENCHIMOL[1], EDGAR SANTO-SILVA[2], CARLOS PERES[3]
[1]Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, 45662900, Ilhéus, Brazil
[2]Universidade Federal Rural de Pernambuco, Unidade Acadêmica de Serra Talhada, 56909535, Serra Talhada, Brazil
[3]University of East Anglia, School of Environmental Sciences, NR47TJ, Norwich, UK

Hydroelectric projects have been rapidly expanding across lowland Amazonia, driving the conversion of large tracts of pristine forests into forest islands embedded within a vast open-water matrix. Hydropower reservoir archipelagos provide excellent experimental landscapes to assess the impacts of habitat fragmentation on biodiversity. We investigate the effects of plot-, patch- and landscape-scale variables on the patterns of floristic diversity within 34 variable-sized land-bridge islands and three continuous forest sites within one of the largest South American hydroelectric reservoirs, the Balbina Dam. We identified to species level all live trees ≥10 cm DBH within a total of 87 quarter-hectare forest plots, and conducted a comprehensive compilation of functional attributes of each tree species. We then examined species-area relationships (SARs) and the additional effects of patch and landscape scale metrics on patterns of tree assemblage heterogeneity, both in terms of functional and phylogenetic diversity. Although island area was a good predictor of species richness and functional diversity, other forest patch and landscape-scale variables exerted even more powerful forces on tree assemblage composition and phylogenetic diversity, driven primarily by edge-mediated fire disturbance. Our results suggest that area effects are expressed via disturbance-aggravated responses to edge effects, given that trees in smaller islands were most susceptible to edge-related fires and wind-throws, which is consistent with the biotic and abiotic changes occurring near forest patch boundaries. Furthermore, habitat insularization did not affect plant species uniformly, with life-history traits explaining varying degrees of vulnerability. In particular, emergent species associated with shade-tolerant seedlings, large seeds, dense wood and slow growth rates were most extinction-prone. In addition, a measure of mean phylogenetic distance (MPD) between individuals in a community in deep evolutionary time was greatly reduced, matching the proliferation of pioneers species and declining proportion of emergent and large-seeded species. This study clearly shows that edge effects were the main predictors of directional floristic transitions of insular tree assemblages, and that the detrimental effects of fragmentation in land-bridge islands are considerably stronger than in patches embedded within terrestrial landscapes.

O68-08 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Patch isolation and shape predict plant functional diversity in a naturally fragmented Forest

AMARANTA ARELLANO[1], ARTURO DE-NOVA[2]
[1]CINVESTAV, Ecología Humana, 93203, Mérida, México
[2]UASLP, Facultad de Agronomia, 78321, San Luis Potospi, México

Background. It is known that taxonomic diversity can be predicted by the spatial configuration of the habitat, in particular by its area and isolation. However, taxonomic diversity is a poor predictor of ecosystem functioning. While strongly linked to the functionality and stability of ecosystems, little is known about how changes in the spatial configuration of the habitat affect functional diversity. In this study we evaluated whether the spatial configuration of forest patches predicts the functional diversity of plants in a fragmented forest.
Methods. We measured five functional leaf traits (dry matter content, punch force, specific area, size, and thickness) for the dominant plant species in 20 different forest patches in a naturally fragmented forest on the Yucatan Peninsula. Abundance-weighted multivariate (Rao's quadratic entropy and functional pair-wise distances) and by-trait (community weighted mean and standard deviation) metrics of functional diversity were calculated and correlated with some three spatial descriptors of forest patches (size, different isolation measures and shape).
Results. Patch shape and isolation were the most accurate predictors of functional diversity. Patch connectivity was positively correlated with Rao's quadratic entropy while patch shape was negatively correlated with dry matter content, specific leaf area and size; in other words, patches with a more convoluted shape have smaller leaves, with a smaller specific area and more dry matter than roughly circular patches. Other measures of patch isolation, such as distance to nearest patch and distance to the continuous forest, were negatively correlated with leaf punch force and size, respectively.
Conclusion. Because these functional traits are correlated with important ecosystem functions (growth rate, primary productivity and litter decomposition), patch spatial configuration may affect not only functional diversity but also ecosystem functioning.

O68-09 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Functional importance of sacred forest patches in altered landscape

RAJASRI RAY[1], SREEVIDYA E.A.[2], T.V. RAMACHANDRA[1]
[1]Indian Institute of Science, Centre for Ecological Sciences, 560012, Bangalore, India
[2]Bharatihar University, Department of Environmental Science, 641046, Coimbatore, India

Background: The role of sacred forest patches (aka sacred grove) for maintaining biodiversity and offering ecosystem services is well established but the functional aspects of biodiversity have not been explored yet. The current study aims to understand how sacred forest patches can promote functional diversity in an altered landscape.
Method: Twentyfive sacred groves in Palakkad region, Kerala, India have been chosen to assess the distribution of six reproductive traits (pollination mechanism, fruit type, fruit size, seed number, seed size and dispersal mechanism) over the study area. The woody species composition and abundance information was collected through field survey. Details of reproductive traits have been compiled from relevant regional and local flora, other literature and personal observation in field. The data matrix has been analyzed for overall trait state distribution and its relation with environmental parameters and disturbance prevalent in the area.
Result: A total of 86 species have been documented from the studied sacred groves with almost equal representation of evergreen and deciduous members. There is a wide representation of fruit and seed characters but pollination and dispersal mechanisms are governed by single guild like insects and birds consequently indicating the dominance of generalist members in the community. Overall functional score of the groves are inversely related with the disturbance, however, no definite conclusion can be made on environmental influence on functional trait distribution.
Conclusion: We conclude that, sacred groves are important for maintaining functional diversity in otherwise altered landscape. However, the prevalence of generalists indicates the slow decline of their status as a refugia for forest specialists outside the forest.

O68-10 – S68 *Is habitat fragmentation driving tropical forests towards functional homogenization?*
Thursday 23 June / 10:30-15:30 – Rondelet

Simulating tree community dynamics under dispersal failure – Consequences of defaunation to ecosystem processes in fragmented forests

MATEUS DANTAS DE PAULA[1], JÜRGEN GROENEVELD[1], RICO FISCHER[1], FRANZISKA TAUBERT[1], VALÉRIA FORNI MARTINS[2], ANDREAS HUTH[1]
[1]Helmholtz Centre for Environmental Research - UFZ, Ecological Modelling, 04318, Leipzig, Germany
[2]Federal University of Sao Carlos – UFSCar, Natural Sciences, Maths and Education, 13600-970, Araras, Brazil

One of the most prominent consequences of forest fragmentation is the dispersal failure of large seeded (> 15 mm seed diameter) plants caused by the loss of large animals such as wide gaped birds. Consequences of this impact are expected to potentially lead to extinction of large seeded plants and considerable changes of ecosystem functions, but are still unknown. In this study we used the individual based forest simulation model FORMIND to evaluate the spatial and temporal consequences of large seeded tree loss due to forest fragmentation. Based on a forest inventory from the Brazilian Northeastern Atlantic Forest, we analyzed how different fragment sizes (1 – 121 ha) affect forest structure properties (e.g. aboveground biomass) if large seeds are still able to establish without the presence of the dispersal agent. Compared to this control scenario we examined how forest structure and dynamics change if large seeds fail to establish due to increased predation or retained dormancy. Comparing both scenarios, we observed for all fragment sizes a consistent 15% aboveground biomass reduction in the forest community consisting of only small seeded species, except for small-sized 1 ha fragments (only 5% less biomass). Also, besides small seeded, the species composition shifts towards a dominance of mostly pioneer light demanding species, similar to an early successional community. We conclude that the growth of small seeded trees is unable to compensate in structural terms the loss of large seeded plants in fragmented forests, even in large fragments not influenced by edge effects. This experiment thus shows a possible direct link between defaunation and collapse of ecosystem processes.

O69-01 – S69 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 16:00-17:00 – Rondelet

Habitat amount predicts the functional diversity of amphibians in an Atlantic Forest fragmented landscape

MAURICIO ALMEIDA-GOMES[1], CARLOS ROCHA[2], MARCUS VIEIRA[3]
[1]UFRJ, Ecologia, 21941-902, Rio de Janeiro, Brasil
[2]UERJ, Ecologia, 20.550-013, Rio de Janeiro, Brasil
[3]UFRJ, Ecologia, 21941-902, Rio de Janeiro, Brasil

Background: Habitat loss and fragmentation are the most important threats to biodiversity, and there is a straight relationship between biodiversity and ecosystem functioning. Therefore, communities with reduced trait diversity should provide fewer ecological functions. Several studies have shown significant losses of functional trait diversity in response to habitat disturbance, and of species diversity in response to reduced amount of habitat. It remains an open question if the reduction of habitat amount in fragmented landscapes is associated with a reduction in functional diversity of amphibians, the objective of this study. Our hypothesis is that more habitat in local landscapes will provide higher heterogeneity of conditions, hence of functional diversity of amphibians.
Methods: Three continuous forest sites and 21 forest fragments were sampled in an Atlantic forest fragmented landscape. Anurans were detected by visual encounter surveys at nighttime, and only forest species were considered to perform the analyses. For each of the 26 frog species recorded four functional traits were compiled, one continuous (body size) and three categorical (habit, developmental mode and reproductive mode). The amount of habitat (the percentage of forest cover) was measured from the central point of each sampling site using a radius of 1400 m (chosen based on preliminary analyses). Functional diversity was quantified using the functional dispersion (FDis) and Rao's quadratic entropy (RaoQ), and functional group richness (FGR) was used to classify species based on functional traits through a dendogram. Linear Models (LMs) were used to test if FDis and RaoQ were related to the amount of habitat surrounding each sampling site.
Results: Both FDis ($r2 = 0.49$; $F1,22 = 23.6$; $p < 0.001$) and RaoQ ($r2 = 0.59$; $F1,22 = 34.1$; $p < 0.001$) were positively and significantly affected by the amount of habitat in the studied fragmented landscape. Moreover, the cluster dendogram grouped the species mainly by their developmental mode (terrestrial development vs. aquatic larvae) and by their habit (terrestrial, arboreal and reophilic).
Discussion: Our study provides robust empirical evidence on how the total amount of habitat in the «local landscapes» affects functional diversity of frogs. Species living closely associated to rivers and streams inside the forest seem to be the most affected by habitat loss, because most of them were recorded only inside large forest remnants.

O69-02 – S69 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 16:00-17:00 – Rondelet

Resource selection by dung beetles in Neotropical forest fragments and cattle pastures

AMANDINE BOURG[1], FEDERICO ESCOBAR[1], IAN MACGREGOR-FORS[2], CLAUDIA MORENO[3]
[1]Instituto de Ecologia AC, Ecoetologia, 91070, Xalapa, Mexico
[2]Instituto de Ecologia AC, Ambiente y sustentabilidad, 91070, Xalapa, Mexico
[3]Universidad Autónoma del Estado de Hidalgo, Centro de Investigaciones Biologicas, 42184, Pachuca, Mexico

Both the impact of habitat modification on the food preferences of species and its impact on ecosystem functioning are poorly understood. In this study, we analyzed food selection by dung beetles in 80 tropical forest fragments and their adjacent cattle pastures in the Los Tuxtlas Biosphere Reserve, Mexico. We assessed dung beetle food selection and classified any specialization in resource use quantitatively using a multinomial classification model. We found 21 species of dung specialists, seven carrion specialists, eight generalists and six species too rare to classify. The bait most frequently selected by beetles in this study was dung in both forests and pastures. Specialists tended to remain specialists in both habitats while generalists tended to change their selection of bait type depending on the habitat. In summary, our results show that replacing forests with cattle pastures modifies the patterns of resource selection by dung beetles and this could affect ecosystem functioning.

O69-03 – S69 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 16:00-17:00 – Rondelet

Wildlife corridors for persistence of Borneo mammal metacommunities

BRODIE JEDEDIAH
University of British Columbia, 401-5788 Birney Ave, V6S0A2, Vancouver, Canada

Elucidating how dispersal and landscape connectivity influence the biodiversity persistence at regional scales will shed light on natural processes structuring ecosystems and help prioritize conservation actions in an increasingly fragmented world. Much of the theoretical and mathematical development of metapopulation and metacommunity concepts has been based on simplified experimental systems or simulated data. We still have limited understanding of how variation in the landscape matrix (the area between habitat patches) and species-specific differences in dispersal ability contribute to metacommunity dynamics in heterogeneous landscapes. Here I assess how landscape connectivity affects the stability of a metacommunity of rainforest mammals in Borneo, a tropical biodiversity hotspot, where protected areas are increasingly isolated by ongoing habitat disturbance and loss. I use a combination of hierarchical models of local abundance, circuit-theory-based dispersal analysis, and metapopulation models. My goal was to understand which landscape links were the most important to metapopulation persistence and metacommunity stability, so that forest in these areas could be protected as wildlife corridors. Dispersal links were particularly important if they were short and connected two large patches. This was partly because only the very shortest links could be traversed by poorly dispersing species, including small herbivores such as chevrotains (Tragulus spp.) and porcupines. Links that join large patches into a "super-patch" may also promote island-mainland rather than Levins-type metapopulation dynamics for good dispersers, particularly large carnivores such as clouded leopards (Neofelis diardi) and sun bears (Helarctos malayanus), reducing metapopulation extinction risk and thereby enhancing metacommunity stability. Link importance to metacommunity stability was highly correlated between heterogeneous and homogeneous landscapes. But link importance to metapopulation capacity varied strongly across species, and the correlation between heterogeneous and homogeneous landscape matrix scenarios was low for poorly dispersing taxa. This suggests that the environmental conditions in the area between habitat patches –the landscape matrix– is important for assessing certain individual species but less so for understanding the stability of the entire metacommunity.

O69-04 – S69 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 16:00-17:00 – Rondelet

Lizard responses to habitat insularization induced by a mega hydroelectric dam in the lowland Amazon

ANA FILIPA PALMEIRIM[1], CARLOS A. PERES[2], MARCUS VINÍCIUS VIEIRA[1]
[1]Universidade Federal do Rio de Janeiro, Departamento de Ecologia, 21941-902, Rio de Janeiro, Brazil
[2]University of East Anglia, School of Environmental Sciences, NR47TJ, Norwich, UK

Major hydropower infrastructure is leading to significant biodiversity loss worldwide. In Brazil, both the government and private investors are expanding hydroelectric generation across the Amazon, whereby 30 new large dams to be constructed the next three decades will generate ≈ 32,800 MW. After damming, terrestrial species typically become stranded in land-bridge islands of varying sizes, isolated within the reservoir. These insular forests are therefore isolated by an aquatic matrix, that operates as an effective barrier to dispersal by terrestrial organisms. Understanding the impact resulting from those large-scale enterprises is critical to inform, if not to avert, the ongoing blitzkrieg of dam development. Here, we document lizard assemblages within land-bridge islands of varying sizes and degree of isolation in a major Central Amazonian hydroelectric reservoir. This is 28-yr-old dam flooded ~4,438 km^2 of primary forest, generating >3,500 land-bridge islands. We further compare insular lizard communities with those in mainland continuous forests surrounding the reservoir, including lowland areas that were inundated by the reservoir.
We sampled 28 land-bridge islands and four mainland regions, including both the hilltops and riparian areas, using 100L-pitfall traps. The sampling effort was proportional to island area and therefore greater in the mainland, totalling 6,228 trapping-days.
We obtained 1,107 records of lizards from 19 species, two of which were only recorded along stream banks in the mainland. Habitat loss due to insularization was the main variable explaining lizard species richness and composition along the gradient of island size and isolation.
Observed residual lizard assemblages, particularly within small and most isolated islands, consisted of an oversimplified set of widely-distributed species corresponding to habitat generalists that appear to be able to persist even in the most severely degraded forest habitat, yet these are the most frequent islands throughout the reservoir. These results emphasize the need to preserve specific habitats on smaller islands to retain herpetofaunal diversity in such archipelagic landscapes, which should be considered in environmental impact assessments of future hydroelectric dams.

O70-01 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

The limits of ecosystem services from forest to small-scale cocoa and coffee yields in Ghana and Ethiopia

ALEXANDRA MOREL[1], MARK HIRONS[2], YADVINDER MALHI[1], KEN NORRIS[3], EMILY BOYD[4], ELIZABETH ROBINSON[2], CONSTANCE MCDERMOTT[1]
[1]University of Oxford, School of Geography and the Environment, OX1 3QY, Oxford, United Kingdom
[2]University of Reading, School of Agriculture, Policy and Development, RG6 6AR, Reading, United Kingdom
[3]Zoological Society of London, Institute of Zoology, NW1 4RY, London, United Kingdom
[4]University of Reading, Geography and Environmental Science, RG6 6AB, Reading, United Kingdom

Background: ECOLIMITS is an interdisciplinary, Ecosystem Services for Poverty Alleviation (ESPA) funded project exploring the ecological limits of ecosystem system services (ESS) for supporting small-scale production of cocoa (Theobroma cacoa) in Ghana and coffee (Coffea arabica) in Ethiopia. We began collecting data in mid-2014 for both sites and have captured yield measures for a relatively representative year and a crop cycle severely impacted by the 2015/16 El Nino.
Methods: To assess landscape and on-farm management factors affecting ESS and crop yields in Ghana, we established 36 plots in a cocoa landscape along a forest-distance gradient from Kakum National Park as well as three forest monitoring plots. In Ethiopia we set up 54 coffee monitoring plots across forest patch, management and altitudinal gradients and two forest monitoring plots within the UNESCO Yayu Biosphere Reserve. The ESS we collected were net primary productivity (NPP), above-ground and below-ground carbon, biodiversity (both conservation and functional values), soil fertility, nutrient cycling, micro-climate, pollination and pest control. In Ghana, we sampled monthly cocoa disease and fruitset variables in each cocoa plot, while ten plots were intensively sampled for NPP components. In Ethiopia, we monitored fruitset and coffee disease at regular intervals throughout the crop cycle as well as intensively monitoring six plots for NPP. We also surveyed our study farmers to establish the intensity of their farm management in order to assess the contribution of ESS and labour/chemical inputs to crop yields.
Results: Our initial assessment of the data has revealed a negative but differentiated impact of the current El Nino climate shock on cocoa/coffee yields in both sites. It is apparent that landscape factors, particularly forest distance and elevation, are mitigating the temperature and humidity extremes these systems are experiencing. On-farm shade management is another important influence on disease incidence and yield.
Discussion/Conclusion: We will be using these results to parameterize a household-level, bio-economic model, where trade-offs between off-farm ESS, on-farm management decisions and household poverty measures can be explored. We intend to assess the net benefit, positive or negative, of intact natural systems for crop yields and whether on-farm tree management can make a difference to the incomes of small-scale cash crop farmers.

O70-02 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Pollination and pest control in cocoa agroforestry landscapes

THOMAS CHERICO WANGER[1], MANUEL TOLEDO[2], TEJA TSCHARNTKE[2]
[1]Swedish University of Agricultural Sciences, Department of Ecology, 75007, Uppsala, Sweden
[2]University of Göttingen, Agroecology, 37077, Göttingen, Germany

The International Cocoa Organization has repeatedly predicted cocoa (Theobroma cacao L.) supply shortages for chocolate production. As supply deficits are linked often to extreme weather events, farmers depend on sustainable and agroecological adaptation strategies to sustain yields and supporting ecosystem services such as pollination and biological pest control. For example, effective shade tree management in agroforestry systems can enhance plantation resilience against drought effects and protect ecosystem services. In reality, cocoa farmers often opt for non-agroecological strategies with less shade trees and more chemical inputs, decreasing the potential for climate change adaptation and ecosystem service provisioning for biological pest control and pollination.
Building on our research in Indonesian cocoa agroforestry landscapes, we illustrate how mismanagement of cocoa plantations can strongly affect biocontrol. For example, a recent long-term experimental approach has shown that commonly applied pesticides such as Glyphosate and Cypermethrin deplete amphibian and reptile communities. This jeopardizes amphibian biocontrol services, positively linked to yield. Moreover, experiments in Indonesia have shown that increasing pollination by 10 to 40% can almost double cocoa yields. Thus, adjusting plantation management to facilitate biological pest control and to increase pollinator abundance may facilitate immediate yield improvements in major cocoa growing regions. Effective plantation management will strongly depend on the ecological knowledge of pest control and pollinating agents. Only then, farmers can be engaged in production strategies to satisfy increasing demands for chocolate sustainably and in a changing climate.

O70-03 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Connectivity modelling of pollination services in a tropical landscape

CHARLOTTE PAVAGEAU[1], CLAUDE GARCIA[2], JABOURY GHAZOUL[1]
[1]ETH Zürich, USYS, 8092, Zürich, Switzerland
[2]CIRAD, UPR BSEF, 34398, Montpellier, France

Protecting pollinators to stabilize crop production is a critical strategy reconciling conservation and agricultural priorities. However, in complex agricultural landscapes, the heterogeneous distribution of resources and pollinators often leads to a disparate delivery of the pollination service. An integrated management of this ecosystem service at the farm and landscape level would require a better understanding of its underlying mechanisms.
In this study, we explored how forest patches, coffee agroforests and other components of the agro-ecological matrix influence the abundance of pollinators in coffee plantations in the Kodagu district, India. We implemented a probabilistic model of dispersion of honeybees from their nesting habitats to the target flowers using the novel circuit theory. Within this framework, we distinguished between two types of resistance surfaces influencing ecological flows: a matrix resistance representing the permeability to movement and a ground resistance representing the attractiveness for forage in a given patch. We derived the resistance surfaces based on the following landscape characteristics: percentage of forest cover, land-use types, and probability of coffee flowering. We interpreted the model output as the probability of a bee foraging in a patch. We used field data on bee activity in 110 coffee plantations to parametrize the resistance surfaces and validate our results.
Our analyses indicated that temporal changes in floral availability throughout the season is the main factor influencing bee abundance and explained at least 55% of the variance among coffee plantations. However, none of the other landscape characteristics improved significantly the predictions on bee visit. The circuit theory model provides a simple mechanistic approach to simulate how pollinators adapt their foraging distance to their environment. The approach has useful implications for the management of pollination services at the landscape scale, and in particular on the coordination of the date of irrigation and subsequent coffee blossom between farmers.

O70-04 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Multi-scale approach of crop microclimates in complex agro-ecological landscapes in Ecuador: towards new pest management strategies?

EMILE FAYE[1], FRANÇOIS REBAUDO[2], MARIO HERRERA[3], OLIVIER DANGLES[2]
[1]CIRAD, UPR Hortsys, F-34398, Montpellier, France
[2]IRD, UMR EGCE, 91190, Gif-sur-Yvette, France
[3]Pontifica Universidad Cato lica del Ecuador, Facultad de Ciencias Exactas y Naturales, 170150, Quito, Ecuador

Microclimates have long been recognized in controlling the physiology and ecology of species. However, in the context of global warming and increasing climatic variability, a major uncertainty that hampers effective pest management is related to the thermal characteristics of agricultural landscapes, which are known to have profound effects on insect pest dynamics. Here, we addressed the issue of considering microclimates experienced by crop pests in their environments to infer their distribution and develop innovative pest control strategies based on processes of thermal agro-ecology.
We assessed the heterogeneity of microclimates experienced by pests and natural enemies in complex agricultural landscapes of Ecuador (from 2800 to 3600 m.a.s.l.), made of various crop types and natural habitats. The assessment of microclimates was performed at the agrosystem, crop field, and plant scales using a combination of UAVs, thermal cameras and temperature micro-loggers. Then, we determined the relationship between microclimates heterogeneity (characterized using spatial metrics) and pest occurrences (measured in the field with pheromone traps and local plant samplings).
Results revealed that microclimates heterogeneity must be taken into consideration when estimating ectotherm occurrences. Indeed, at the landscape scale, microclimates of crops and natural habitats substantially affect pest dynamics. At the field scale, the spatial metrics shaping microclimatic conditions are significantly related to pest occurrences. And at the plant scale, we found that pests can access in their close vicinity (<1.2 m) most of the thermal micro-environments recorded at the field level.
In complex agro-ecological landscapes, there is likely a wide range of microclimatic conditions resulting in the presence of locally-suitable and unfavourable conditions for ectotherms (crop pests but also natural enemies), the existence of which might not be apparent at a coarser resolution. Consequently, this work stresses the need of a better incorporation of microclimatic data into models of species distribution (and vulnerability to climate change) and evidences that microclimates might provide new leverage for innovative agro-ecological pest management.

O70-05 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Local Knowledge and Boundary Objects: Understanding the underlying drivers of change in a upland socio-ecological system to better resolve the conservation and development trade-off

SWEN BOS[1], ANNE DRAY[1], B.R. RAMESH[3], CLAUDE GARCIA[2]
[1]ETH Zurich, USYS, 8092, Zurich, Switzerland
[2]Cirad, IS, 34398, Montpellier, France
[3]Institut Français de Pondichéry, Department of Ecology, 605001, Pondicherry, India

The Karbi, a scheduled, semi-autonomous hill tribe in Assam, India, use shifting cultivation to produce upland rice, while hunting and gathering forest resources to sustain their livelihoods. Population growth, urbanization, the emergence of cash crops and new economic opportunities are significantly altering the landscape. The northern Karbi Anglong hills also have a well-established conservation value. The adjacent Tiger Reserve, Kaziranga National Park, hosts the world's largest population of Asian rhinos and wild water buffalos, highest density of tigers, as well as other flagship species such as elephants, rare deer species, and birds. Each monsoon season the park is flooded by the Brahmaputra River, forcing most wildlife out of the protected area and into the forested hills of the Karbi. These movements of wildlife create serious conflicts with the local farmers. The changes brought about by developments in the agricultural system in turn hamper the conservation effort of the government as the loss and degradation of forest cover in the hills reduces landscape connectivity.
To understand and explore the constraints and decisions of the primary landscape managers, we translated the socio-ecological system into a flexible boundary object, a role playing game. To do so we merged two approaches, the Local Ecological Knowledge framework and Companion Modeling. Playing the game, local farmers and other stakeholders can safely explore all the branches of their decision trees, shaping possible future landscapes, and formulating scenarios of change. The impacts of individual farm management under these different scenarios can then be translated to landscape scale, and the positive and negative outcomes of farm and forest management assessed and discussed using visual indicators derived from the game.
The main constraint shaping landscape dynamics identified by the farmers is the delicate balance of allocating labour and capital so food security is maintained, while also covering the increasing household costs of education and healthcare. Any change to the present balance could send the landscape into different basins of attraction. Conservation efforts trying to link the National Park in the lowlands with the ongoing processes on the upland should take these elements into consideration. Understanding the underying drivers of change in such a complex and dynamic landscape requires integrated and transdisciplinary approaches such as the ones developed here.

O70-06 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Understanding farmers: using role playing games to track landscape trajectories

ANNICK RAVAKA[1], PATRICK O.WAEBER[2], HARIFIDY R. RAKOTO[1], LUCIENNE WILMÉ[3], BRUNO S. RAMAMONJISOA[1], AINA NAVALE A. RATOVOSON[1]
[1]Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, Département des Eaux et Forêts, 101, Antananarivo, Madagascar
[2]Forest Management and Development, Swiss Federal Institute of Technology Zurich, Department of Environmental Sciences, 8092, Zurich, Switzerland
[3]Missouri Botanical Garden, Madagascar Research & Conservation Program, 101, Antananarivo, Madagascar

Natural resource management is becoming increasingly complicated and complex. The water-food-energy nexus constitutes tough challenges for the decision makers. A majority of the rural poor in Madagascar are involved in agricultural activities. In order to better understand changing landscapes, we address the following questions: (i) How do the cumulative decisions by small-scale farmers translate to landscapes, and (ii) what are possible trajectories? The assumption is that small-scale farmers' decisions on land use affect or change land cover. The current study is located in the subwatershed of the Alaotra lake in the Maningory watershed; the western part of the Maningory watershed secures some 20% of Madagascar's rice consumption, while the eastern part is dominated by cash crops (cloves, letchi). To understand the underlying process of land use and change, we have developed a model that reflects the farmers reality. We have used Companion Modeling, a participatory-based scientific approach based on an inductive process of creating conceptual models from field evidence and judgments with restitution to knowledge providers in the form of interactive games (the "models"). Preliminary results engaging with 150 farmers and 30 decision makers show that three main features drive the landscape dynamics in the watershed: (i) the market, linked with crop type and access to road, (ii) human migration, and (iii) natural factors of land use change. This model allows the concurrent engagement of various stakeholders (e.g., farmers and decision makers) and hence constitutes a technical and economical feasible tool for land use and management.

O70-07 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Pest predation services of birds and bats in tropical forests and agroforestry landscapes

BEA MAAS
University of Göttingen, Agroecology, 37077, Göttingen, Germany

Understanding ecosystem services and their impact on human well-being and sustainable resource use have become a research focus in ecology, especially because rapid agricultural expansion and intensification is threatening biodiversity and many of Earth's critical life-support systems. Birds and bats have received great attention in this regard because they provide valuable economic benefits to farmers, particularly in tropical small-scale agroforestry systems. But only in recent years, the effects of birds and bats on arthropod suppression, multitrophic interactions and crop yields have been evaluated experimentally and in relation to local and landscape factors to understand their relative importance.
I will present results from a global review in which we analyzed the existing body of studies on bird and bat services in forests, cacao, coffee, and mixed fruit orchards across the tropics. We have reviewed the distribution patterns of insectivorous birds and bats, effects on trophic cascades, and drivers of pest limitation services at local and landscape level. Despite revealing global patterns of bird and bat predation services, our results provide implications for improved agricultural management, with respect to socio-ecological challenges in smallholder agroforestry systems.
The results of our review show that for birds, but not bats, community composition and relative importance of functional groups changes conspicuously from forests to agroforests, with reduced representation of insectivores in the latter. The relative importance of birds versus bats in regulating pest abundances varies with season, geography and management.
Using examples from individual studies and community wide manipulation experiments from different tropical regions, I will discuss the potential value of bird and bat ecosystem services for reconciling conservation and improving sustainable use of biodiversity. Our findings indicate that the proximity of old growth forests and the presence of abundant insectivores increase pest suppression services in tropical agroecosystems. Targeted management of such key factors may even enhance the benefits for farmers and biodiversity conservation in tropical agroforestry landscapes.

O70-08 – S70 *Free session: Habitat fragmentation and biodiversity*
Thursday 23 June / 08:00-10:00 – Barthez

Multi-dimensional poverty and tree crops in African agroforest systems

MARK A. HIRONS[1], STEPHEN ADU-BREDU[2], MICHAEL ADU SASU[3], REBECCA ASHLEY ASARE[3], EMILY BOYD[4], SHELEME DEMISSE[5], TADESSE WOLDEMARIAM GOLE[5], TECHANE GONFA[5], YADVINDER MALHI[1], JOHN MASON[3], ALEXANDRA C. MOREL[1], CONSTANCE L. MCDERMOTT[1], KEN NORRIS[6], ELIZABETH J.Z. ROBINSON[7]
[1]University of Oxford, School of Geography and the Environment, OX1 3QY, Oxford, UK
[2]Forest Research Institute of Ghana, Forest Research, FORIG, Kumasi, Ghana
[3]Nature Conservation Research Centre, NCRC, NCRC, Accra, Ghana
[4]University of Reading, School of Geography, RG6 6AB, Reading, UK
[5]Environment and Coffee Forest Forum, ECFF, ECFF, Addis Ababa, Ethiopia
[6]Institute of Zoology, Zoological Society of London, NW1 4RY, London, UK
[7]University of Reading, School of Agriculture, Policy and Development, RG6 6AR, Reading, UK

Background: The management of tree-based cash crops is critical to the ongoing flow of ecosystem services and the long-term delivery of benefits from ecosystems. In many of these systems there is concern about persistent levels of poverty among the farmers who manage and depend on agro-forestry. Using the case of Ethiopian coffee systems and Ghanaian cocoa systems, the ESPA (Ecosystem Services for Poverty Alleviation) ECOLIMITS project examines the linkages between cash crops in agro-forestry landscapes and poverty. A nuanced assessment of the contributions of cash crops to poverty – conceived as a multi-dimensional phenomena and shaped by demographic factors such as age, gender and ethnicity is essential to understanding the variety of ways that cash crops do, and do not, influence poverty dynamics. How poverty in turn constrains and shapes the choices that farmers make is examined to provide insights to the linkages between poverty and the ecological dynamics of wider agro-forestry systems.
Methods: The analysis is based primarily on a randomly sampled household survey stratified by gender and wealth (Ethiopia n=241; Ghana n = 108). Descriptive statistics and linear regressions are conducted to assess the importance of cash crops to multiple dimensions of poverty and interactions of poverty with key management activities. These methods are supplemented by a series of community focus groups and semi-structured interviews with key stakeholders at multiple levels which situates the findings in their wider institutional landscape.
Results: Initial findings suggest that cash crops play a vital role in some, but not all dimensions of poverty with assets, food security and satisfaction consistently correlating with cash crop income. The role of policy relevant variables such as tenure, access to credit and extension do not have a clear impact on productivity or poverty. Analyses which seek to disaggregate along demographic lines as well as multiple dimensions of poverty are faced with many challenges, in particular endogeneities and qualitative aspects of key poverty dimensions such as satisfaction and empowerment pose analytical difficulties. A mixed method approach is essential to examine complex socio-ecological systems.
Discussion/Conclusion: These findings have implications for the design of projects and programmes which seek to simultaneously conserve ecosystem services provision and improve wellbeing such as REDD+ and sustainable intensification projects.

O71-01 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Applying approaches from functional biodiversity to understand agriculture, nutrition, and environment

STEPHEN WOOD
Yale University, School of Forestry and Environmental Studies, 06611, New Haven, USA

Intensifying agriculture has become a target for feeding the planet while minimizing environmental impact. Yet intensification can create environmental and human harm when production focuses on crops that do not contribute to nutritional needs and require large amounts of land. I will present on recent work that applies tools and concepts of functional trait diversity to food systems to understand how to feed the planet well and reduce environmental impacts.

O71-02 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Functional ecology as a framework for restoring degraded human-modified landscapes in East Africa

MADELON LOHBECK, LEIGH WINOWIECKI, TOR VÅGEN
World Agroforestry Centre (ICRAF), GeoScience lab, 30677-00100, Nairobi, Kenya

Functional ecology provides a framework that allows to mechanistically link land-use with ecosystem composition and ecosystem functioning. However it's application is mostly limited to (semi-)natural systems and small spatial scales. Here we apply a functional ecology framework to human-modified landscapes in contrasting agroecological and Koeppen-Geiger climatic zones in East Africa: sub-humid montane regions with the equatorial monsoon (Am) climate zone of eastern Uganda and drier highlands in the warm temperate climate (Cwb) of central Ethiopia. The Ugandan sites are characterized by agroforestry systems with banana, maize, and beans as the stable crops and patches of natural forest. The Ethiopian sites are characterized by croplands, dominated by finger millet, teff, sorghum, wheat and maize, and extensive grazing lands. Land degradation is a recurring phenomenon across the four sites, indicated by high erosion and lowered soil organic carbon and nitrogen. We tested whether the aboveground woody biomass, abundance of specific functional traits and functional diversity explain soil fertility and erosion prevalence across managed landscapes. We used the land degradation surveillance framework (LDSF), a multi-scale assessment of key indicators of soil and land health to conduct biophysical field sampling. The sites are 10 by 10 km landscapes in which tree inventories and composite topsoil (0-20 cm) sampling was carried out in 50 100m2 plots. Unlike expected, we found that tree functional diversity decreased carbon and total nitrogen in the soil, and increased erosion prevalence in Uganda, whereas no diversity effect was found in Ethiopia. In heavily managed landscapes where most trees are planted, the relationship between functional diversity and soil properties is largely indirect and affected by local people's preferences and management strategies rather than by environmental filtering. Importantly, we found that particular functional types, such as N-fixing trees, were positively related to soil health across the landscapes, while exotic species tended to increase land degradation. This work provides much needed evidence for selecting trees that contribute to restoring soil health and services on which farmers depend. Understanding the functional ecology of managed systems at the landscape scale is an important step towards making informed decisions on how to restore degraded farmlands inside human-modified landscapes.

O71-03 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Adult tree abundances and plant traits can help predict tree species' natural regeneration and delivery of ecosystems services in agricultural landscapes

M. JIMENA ESQUIVEL SHEIK[1], BRYAN FINEGAN[2], JOHN R. HEALEY[3], FERNANDO CASANOVES[4]
[1]Tropical Agricultural Research and Higher Education Center (CATIE), Livestock and Environmental Management Program, 7170, Turrialba, Cartago, Costa Rica
[2]Tropical Agricultural Research and Higher Education Center (CATIE), Forest Conservation Program, 7170, Turrialba, Cartago, Costa Rica
[3]Bangor University, School of Environment, Natural Resources and Geography, L57 2DG UK, Bangor, Gwynedd, Wales, United Kingdom
[4]Tropical Agricultural Research and Higher Education Center (CATIE), Biometry Unit, 7170, Turrialba, Cartago, Costa Rica

Capacity to naturally regenerate (CNR) is an ecological property of the species in plant communities that is key to conserve the decreasing fraction of local diversity remaining in agricultural lands and associated processes. A reduction of tree cover diversity can negatively affect present and future delivery of ecosystem services (ES). Plant traits (PT) can help predict these effects if they are associated with CNR after land use change. We propose to use the relationships between PT and tree species demography to evaluate the potential changes in ES on the basis of current adult tree composition and management in tropical agroecosystems.
Our methodology uses the abundance of tree species at different development stages (adults, saplings and seedlings) to evaluate their contribution to CNR under disturbances generated by agricultural management. In addition, we propose the use of 17 PT related to three main trait dimensions (leaf, whole plant and reproductive), which are highly relevant to tree species tolerance of disturbance. The key PT are i) leaf area, specific leaf area, leaf dry matter content, carbon, leaf phosphorus and nitrogen content, foliar tensile strength; ii) wood density, maximum tree height, leaf phenology; and iii) fruit and seed mass, volume, shape and dispersal mode.
This PT methodological approach allows us to correlate variation in functional characteristics with variation in species' CNR in agricultural lands. Research in active pasturelands in Central America show that tree cover diversity is dominated by species with different characteristic to those with low CNR, highlighting how the impact of current management on tree regeneration can affect current and future ecosystem functioning. Changes of litter decomposition and associated nutrient cycling in active pasturelands for example, can possibly emerge depending on the relationships among leaf traits, litter decomposition rates and CNR. We conclude that both sets of information, tree species' (a) adult abundance and population structure and (b) plant traits, can help us to predict tree species' CNR and their capacity to deliver ES in agricultural systems like active pasturelands. Ecosystem functioning will be affected as a consequence of the limited CNR of some tree species with particular PT under current conventional livestock management practices common over all Central American agricultural landscapes.

O71-04 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Can functional traits explain the dynamic of undesirable species in tropical grasslands?

SIMON TAUGOURDEAU[1], JOHANN HUGUENIN[1], GÉRARD BALENT[2], VINCENT BLANFORT[1]
[1]CIRAD, UMR SELMET, 34398, Montpellier, France
[2]INRA, UMR DYNAFOR, 31320, Castanet-Tolosan, France

In wet tropical conditions, the improved pastures are usually implanted after deforestation and most times with a single forage grass (mainly C4 and exotic grasses) and more rarely with legumes.
These artificial grasslands ecosystems are more unstable than native pastures. Grasslands can be degraded by the colonization of "undesirable" plants. These species are unpalatable and so reduce the production of the grasslands ("agronomical impact"). Some of these species are also invasive and colonize also the natural forests ("ecological impacts").
Understand the dynamics of undesirable species regarding the climate, soil, management and the vegetation is the key to propose sustainable management of tropical grasslands.
The studies of undesirable plants are generally using species approaches within one region. Considering the diversity of tropical area, the undesirable species may differ from one region to another. These species approaches limit the generality of the results of these studies.
The objective of this work is to test the use of functional trait approach for the understanding of the dynamics of undesirables' species. We used datasets from three different tropical regions: the Reunion Island in Indian Ocean New Caledonia Island in the Pacific Ocean and the French Guyana in the Amazonian region. The islands are biodiversity hotspots threaten by biological invasion. The grassland ecosystems studied are a major element of plants invasion process. In the French Guyana the grassland are implanted after deforestation of Amazonian forest.
In each region, the grassland botanical composition and the dynamic of undesirable species were monitored during several years: 1994,1995,1996,2001 and 2004 for the Reunion, from 1999 to 2005 for New Caledonia and from1997 to 2000 and from 2010 to 2013 for the Guyana.
The trait values of 84 functional traits were extracted from the TRY database (www.try-db.org) from the 367 species presented in the surveys. We imputed some of the missing value using different methods.
Our first step was to compare the functional traits of the different undesirables to see if we can identify common functional strategies along the three regions. Secondly, we try to understand the dynamics of these different groups and the effect of management and climate on the different undesirable strategies.
In conclusion, we discuss the interest and the limits of using functional traits for the understanding and the mangement of undesirable species.

O71-05 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Effect of simplification/complexification on functional features of associated trees community in cocoa based agroforestry systems

STEPHANE SAJ[1], PATRICK JAGORET[2], KENNETH MVONDO SAKOUMA[1]
[1]CIRAD/IRAD, UMR System, BP2572, Yaounde, Cameroon
[2]CIRAD, UMR System, 34060, Montpellier, France

Africa's cocoa producing countries are challenged to identify sustainable cropping models to replace the currently prevailing monoculture systems. In this context, cocoa-based agroforestry systems (c-AFS) from Central Cameroon could represent an initial model from which to work on as they are able to support many ecosystem services and maintain a sound cocoa production on the long-term. In Talba, an old pioneer front, various cocoa systems cohabit for about 40 years. Some are very simple, close to the conventional model, while others are rather complex and contain many associated tree species. Such circumstances represent an opportunity to check for differences in their functioning and management in very similar pedoclimatic and ecological conditions.
In this study, we focused on functional features of associated trees community (AT) within a set of 3 types of c-AFS. We studied 54 plots of $800 m^2$ and setup 3 groups according to their AT density (ind.ha-1): low (< 50), medium (50 to 99), high (≥ 100). The systems studied ranged from 5 to 64 years old. We used 5 forest plots as controls. We characterized AT' species diversity, leaf-life span strategy, succession guild, N-fixation and wood specific gravity (WSG). We measured cocoa and AT basal area (BA) and height.
In total, 695 associated trees and 64 species were assessed. Diversity indices and mean WSG increased with AT density. Mean height canopy was found higher at low AT density than in forest. Basal area of non-pioneer light demander, shade tolerant and evergreen species increased with AT density. Basal area of N-fixers was poorly affected by AT density. Cocoa BA steadily increased while AT density decreased. Ageing significantly affected cocoa and AT densities but did not change the relative BA shares between functional features for the groups tested.
The study of AT functional "profiles" shows that farmers' c-AFS management differs according to AT density and affects c-AFS structures and functioning whist making them significantly different from forest. Modelled shifts in AT densities consistently reduce or increase several functional features of the studied c-AFS. This shows that farmers actually manage AT according to some of these features. In the simplest systems AT are solely used for shading and cocoa population favoured. In more complex systems, regularly less input-intensive, associated trees have multiple uses and farmers seem to willingly accept trades-off with cocoa trees development.

O71-06 – S71 *Functional traits in tropical agroecology*
Thursday 23 June / 10:30-12:00 – Barthez

Functional trait-based agroecology: progress and prospects for quantifying trait variation in crops.

ADAM MARTIN, MARNEY ISAAC
University of Toronto, Department of Physical and Environmental Science, and the Centre for Critical Development Studies, M1C 1A4, Toronto, Canada

Studies focused on plant functional traits have been critical for understanding ecological patterns and processes in natural tropical plant communities. However to date, functional trait-based approaches have not been widely used in tropical agroecological research, policy, or practice. While there is a long history of evaluating the causes and consequences of variation in crop "agronomic" or "domestication" traits, few tropical agroecological studies have focused on functional plant traits as commonly envisioned in the ecology or evolutionary biology literature. Here, we will concisely review the potential applications of functional-trait based approaches to agroecological research. We then focus two important knowledge gaps that currently confront trait-based agroecology: 1) limited representation of crops in global functional trait databases, and 2) limited generalized understanding of how key functional traits vary within crop species. We conclude by arguing that crop trait data consolidation initiatives, coupled with field studies designed to capture intraspecific trait variation, are critical in advancing trait-based research in tropical agroecology.

O72-01 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Ecological vulnerability of floristic diversity of tropical dry forest in the high Magdalena River Valley, Colombia, South America

DEL PILAR AGUIRRE MARTIN ADRIANA[1], ADRIANA AGUIRRE[1], OMAR MELO[2]
[1]Universidad Del Tolima, Forestry Science, 730001, Ibague, Colombia
[2]Universidad Austral, Forest Science, 730001, Ibague, Colombia

Scientists have now clear that climate change poses a major riskiness to global biodiversity. New climate patterns alter areas where species persist, deteriorate species interactions and ecosystem processes and modify the intensity and areas of diseases and invasive species. The study area is part of the Inter-Andean valley of the Upper Magdalena in Colombia's central region and the research was conducted in 40 tropical dry forest fragments larger than 50 hectares. Coordinates 5°00'41.46 «N - 74°54'55.50» O and 3°02'35.73 «N - 75°19'09» O. The average annual precipitation 1600 - 1100 mm, the average temperature between 28.5-26.8 ° C. The average altitude is 270-490 m. A plot of 0.25 ha was established in every forest and all trees about 5 cm of diameter were evaluated. Index Climate Change Vulnerability to determine the severity of changes in average temperature and changes in the availability of annual humidity was evaluated. These expressed as the ratio of actual evapotranspiration and potential evapotranspiration by the Humidity Measurement of Hamon. This index integrates projected temperature and precipitation changes to indicate how much drought will occur and provides a more realistic measure of stress in organisms that precipitation itself. 397 species of woody plants of which 52 are endemic were identified. They were classified into 5 categories of vulnerability. For Total Diversity in the extremely vulnerable category has 26% of the species. Highly vulnerable 31%. Moderately vulnerable17%. Not vulnerable (presumably stable) 14%. Not vulnerable (probable increase) 12%. For diversity of endemic species extremely vulnerable category has 43% of the species. Highly vulnerable 34%. Moderately vulnerable 12%. Not vulnerable (presumably stable) by 5%. Not vulnerable (probable increase) 6%. Tropical dry forests of the high Magdalena River Valley are highly vulnerable and floristic diversity is at high risk of involvement by climate change and therefore the natural resource managers must adapt traditional approaches to conservation planning, which mostly operate under the assumption that species do not naturally alter their distributions, to accommodate climate-related stressors.

O72-02 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Adaptation and population dynamics of a tropical spider, Ariamnes (Theridiidae)

ELLIE ARMSTRONG[1], KE BI[2], TYLER LINDEROTH[3], CERISE CHEN[4], ROSEMARY GILLESPIE[4], STEFAN PROST[3]
[1]University of Hawaii, Hilo, Biology, 96720, Hilo, United States
[2]University of California, Berkeley, Museum of Vertebrate Zoology, 94720, Berkeley, United States
[3]University of California, Berkeley, Integrative Biology, 94720, Berkeley, United States
[4]University of California, Berkeley, Environmental Science Policy and Management, 94720, Berkeley, United States

Background: Island archipelagos are constantly changing environments where species diverge and reconnect as islands form and decay. These systems can provide insight into the early stages of speciation and adaptation, especially on island chains which are chronologically arranged, such as the Hawaiian Islands. The spider genus Ariamnes (Theridiidae), is distributed worldwide and has approximately 11 described species endemic to the Hawaiian Islands. Here, we investigate the population dynamics of Ariamnes on the three islands of Molokai, Maui and Hawaii in order to gain insight into how colonization and admixture play roles in the formation of populations.
Method: We generated genome-wide low coverage double digest RADseq (ddRAD) data for 123 individuals across 8 populations. This produced approximately 37,000 variable sites (SNPs) that were subsequently analyzed using the program ANGSD, which infers genotype likelihoods rather than genotype calls to compute population summary statistics. Using these data, we reconstructed the phylogenetic relationships between populations/species, calculated population genetic statistics such as population differentiation (Fst) and diversity (nucleotide diversity and Watterson theta), as well as inferred admixture between populations/species.
Results: We found clear phylogenetic distinctions between the three islands investigated, as well as structure within the Hawaii Island populations corresponding to the age of the site. Interestingly, we found spiders from Hawaii Island to be more closely related to ones from Molokai than Maui, which is not what we expect given the island progression rule. Admixture analyses indicate no substantial admixture between islands as well as between distant populations on Hawaii Island. Genetic diversity was highest on Molokai and comparable for the other populations.
Discussion: As viable habitat on islands is continually threatened by land use and invasions, it will become increasingly important to understand how new biodiversity is formed. Incipient colonization on island chains has in many cases lead to bursts of speciation, but we have very little understanding of the relative importance of admixture and biogeographic processes that happen early on. In this case, we have shown that admixture occurs in the youngest populations on the youngest island. Future work will look to expand analyses to old islands to test the occurrence of admixture in more ancestral populations.

O72-03 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:30 – Barthez

Functional composition of montane tropical forests on contrasting geological formations (Guayana Shield and Andes)

CRISTABEL DURÁN-RANGEL[1], LIONEL HERNÁNDEZ[2], EMILIO VILANOVA[3], HIRMA RAMÍREZ-ANGULO[4]
[1]Instituto Florestal, Floresta Estadual de Assis, 19807-260, Assis, Brazil
[2]Fundação Jardim Botânico do Rio de Janeiro, 22460-030, Rio de Janeiro, Brazil
[3]North Caroline State University, Department of Plant and Microbial Biology, 27695-7612, Raleigh, USA
[4]Universidade Estadual de Campinas, Instituto de Biologia, 13083 – 865, Campinas, Brazil

The Guayana Shield is one of the most ancient geological formations in the world and it is characterized by extreme oligotrophic conditions and strongly acidified soils. High mean values of wood density for the lowland forests on the Guayana Shield compared to other lowland regions in the Amazonas shows that Guayanan forests could present a higher proportion of tree species of low growth. This might be a strategy of these forests that allow persistence on resource-poor soils. The other extreme of the soils nutrients gradient in South America is represented by a younger geological formation, the Andes mountain range, with soils rich in nutrients. Both regions presents tall and dense cloud forests.
A trait comparison (seed mass and wood density) have been made for lowland Guayana and Amazon forests including those with Andean influence in the Western Amazonia. However not yet for montane forests. The pattern of functional composition of montane forests might be different from those of lowland forests, since stand-level wood density of trees in Venezuelan Guayanan forests decreased significantly with increasing elevation. Our aim is investigate the functional composition of montane forests located on the Guayana Shield and the Andes mountain range.
We specifically ask:
- Which are the differences in terms of functional composition between tropical mountain forests on the Guayana Shield and forests on the Andes mountain range?
- Which species and functional group grows best and is most competitive in both forest ecosystems with different availability of soil nutrients?
The data comes from trees of permanent plots established in the Sierra de Lema mountain forests, in the Venezuelan Guayana Shield and La Carbonera mountain forests located in the southwest of the Mérida state, Venezuela. The functional traits to consider are wood density, maximum potential height, diameter increment, seed size and mass. The traits data comes from own measurements, published data in scientific publications and data bases. The data will be analyzed with trait-based approaches.
The research concept will be presented and preliminary results will be discussed.

O72-04 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Phylogenetic control of Amazonian tree traits

FERNANDA SOUZA[1], KYLE DEXTER[2], OLIVER PHILLIPS[1], NIKOLAS FYLLAS[1], DAVID GALBRAITH[1], TIM BAKER[1]
[1]University of Leeds, School of Geography, LS29JT, Leeds, UK
[2]University of Edinburgh, School of GeoSciences, EH9 3JN, Edinburgh, UK

Background: The evolutionary heritage of species plays a major role in determining the ecological niches that they occupy. However, apart from inheritance, a wide range of historical processes that act over time (e.g. divergent selection, convergent evolution, dispersal and extinction) may lead to different trait values compared to ancestors. Thus, although it is often assumed that close relatives are more similar as a result of retaining the characteristics of the ancestral state, in many clades and for some traits, retention of ancestral characters may not have occurred. Thus, rather than being simply assumed, this tendency of closely related species to be more ecologically similar needs to be tested.
Methods: We quantified phylogenetic signal in seven important traits across 497 Amazonian tree genera and assessed whether there are differences in the degree of phylogenetic signal between so-called 'hard' (e.g. growth and mortality rate), and 'soft' traits (e.g. specific leaf area and foliar nutrients) that are related to major axes of life history variation among tropical trees.
Results: We found clear significant phylogenetic signal, present for nearly every trait tested, with hard and soft traits showing similar extents of phylogenetic signal. However, for all of the measured traits, the strength of phylogenetic signal was lower than expected under a Brownian motion model.
Discussion: Our results show that across tropical trees, closely related species tend to have similar functional characteristics, suggesting the potential to use the evolutionary relatedness of species as a means to understand mechanisms of community assembly and as a proxy for measuring ecosystem function. Meanwhile, our finding of less phylogenetic signal than expected under Brownian motion model suggests that these traits have experienced both convergent selection among distantly related lineages and divergent selection among closely related ones. Lastly, the similar extent of phylogenetic signal for all measured tree traits suggests coordinated genetic control on traits over evolutionary time.

O72-05 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Reproductive biology and gene dispersal of Pentadesma butyracea Sabine (Clusiaceae) in Benin

EBEN-EZER B.K. EWEDJE[1], ADAM AHANCHEDE[2], OLIVIER J. HARDY[3]
[1]Université Polytechnique d'Abomey, Faculty of Sciences and Technics of Dassa, BP 14, Dassa-Zoume, Benin
[2]Université d'Abomey-Calavi, Faculty of Agronomic Sciences, BP 526, Abomey-Calavi, Benin
[3]Université Libre de Bruxelles, Faculty of Sciences, Av. F. D. Roosevelt 50, B-1050 Brussels, Brussels, Belgium

Defining appropriate conservation strategies of threatened plant genetic resources as the native African food tree species Pentadesma butyracea requires a good knowledge of mating patterns and their consequences for population genetics. We examined its main reproductive traits (phenological pattern, floral morphology, pollinator assemblage, seed production and germination conditions) on 77 adult individuals from three natural populations occurring in the Sudanian phytogeographical zone. Microsatellite markers were used to estimate the outcrossing rate, levels of correlated paternity and fine-scale spatial genetic structure of adults and maternal sibships for a small and three large populations.
In Benin, Pentadesma butyracea flowers once a year from September to December. Flowering entry displayed less variation among populations (0-14 days) than among individuals within populations (0-18 days). However, a high synchrony of different floral stages between trees due to a long flowering period (c. 2 months per tree), might still facilitate pollen exchange. Pollen-ovule ratio was 577 ± 213 suggesting facultative xenogamy. Microsatellites data strengthened these findings showing that P. butyracea is mainly an outbreeder species (tm = 0.88-0.95). The apical position of inflorescences, the yellowish to white greenish flowers and the high quantity of pollen and nectar per flower (1042 ± 117 μL) represent floral attractants that predispose the species to animal-pollination. The main pollinators were two sunbirds (Cyanomitra verticalis, Cinnyris coccinigastrus) and three Hymenoptera (Apis mellifera, Meliponula togoensis, Hypotrigona sp.). The mean pollen dispersal distance was estimated between 50m and 450m, but up to 21% pollen might immigrate from external sources. The smallest population displayed slightly higher correlated paternity than the large populations (rp = 0.37 vs. rp = 0.17-0.30), suggesting pollen limitation in the former while large populations are connected through gene flow.
In conclusion, the natural reproduction of P. butyracea is not limited by its ecology so that we hypothesize anthropogenic activities to be the reason for the threatened status of P. butyracea in Benin.
Keywords: conservation, correlated paternity, Pentadesma butyracea, pollen dispersal, sexual reproduction

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O72-06 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Functional trait differences influence neighborhood interactions in a hyperdiverse Amazonian forest

CLAIRE FORTUNEL[1], RENATO VALENCIA[2], S. JOSEPH WRIGHT[3], NANCY C. GARWOOD[4], NATHAN J.B. KRAFT[1]
[1]University of California, Los Angeles, Department of Ecology and Evolutionary Biology, 90095-1606, Los Angeles, USA
[2]Pontificia Universidad Católica del Ecuador, Laboratorio de Ecología de Plantas, Escuela de Ciencias Biológicas, 17-01-2184, Quito, Ecuador
[3]Smithsonian Tropical Research Institute, Center for Tropical Forest Science-Forest Global Earth Observatory, 0843–03092, Balboa, Republic of Panama
[4]Southern Illinois University, Department of Plant Biology, 62901-6509, Carbondale, USA

Background: As distinct community assembly processes can produce similar community patterns, assessing the ecological mechanisms promoting coexistence in hyperdiverse rainforests remains a considerable challenge. A promising way forward is to quantify the linkage between individual performance and the functional composition of its local neighborhood by utilizing forest dynamics data that captures variation in performance rather than simple patterns of species co-occurrence.
Method: Combining demographic data from a lowland rainforest 25 ha plot in Ecuador with eight functional traits and phylogeny for ca. 1100 tropical tree species, we use spatially-explicit neighborhood models of tree growth to quantify how functional trait differences and phylogenetic distance predicts variation in growth and neighborhood crowding effects for 315 tree species. For each species, we estimate model parameters using maximum likelihood and compare alternate models using the Aikaike Information Criterion corrected for small sample size.
Result: We find that functional trait differences reflect variation in (i) species maximum potential growth, and for some species (ii) the intensity of interspecific interactions, and (iii) species sensitivity to neighborhood crowding. We show that 28% of the 315 most abundant tree species are best described by models including neighborhood effects. Neighborhood effects were not detected in the remaining 72%, which may reflect low statistical power to model rare taxa and/or species insensitivity to neighbors.
Discussion/conclusion: Examining variation in tree growth as a function of neighborhood structure, we emphasize ongoing challenges inherent in assessing species dynamics in hyperdiverse systems where most species are rare. Our results highlight the range of ways in which functional trait differences can shape community dynamics in highly diverse rainforests.

O72-07 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

The economy of non-structural carbohydrates and its relationship with plant functional traits in tropical and temperate tree species

JORGE RAMÍREZ[1], JUAN POSADA[2], TANYA HANDA[1], CHRISTIAN MESSIER[3]
[1]Université du Québec à Montréal, Biological Sciences, H2X 1Y4, Montreal, Canada
[2]Universidad del Rosario, Biology Program, 111221, Bogotá, Colombia
[3]Université du Québec en Outaouais, Natural Sciences, J0V 1V0, Ripon, Canada

Background. Life history strategy predicts that species in closed-canopy forests vary along a continuum from long-lived/slow-growing to short-lived/fast-growing. Slow-growing species are characterized by having a suite of 'conservative´ functional traits such as low specific leaf area (SLA) and low leaf maximum photosynthetic capacity (Amax), while fast-growing species have 'acquisitive' traits such as high SLA and high Amax. In parallel, storage of carbohydrates plays a major function allowing plants to survive periods of negative carbon balance during unfavorable conditions. However, there is contradictory information regarding whether this conservative/acquisitive plant traits axis is functionally related to allocation to reserves. The aim of our study was to evaluate the relationships between allocation to reserve and functional traits in tropical and temperate tree species. We hypothesized that species that allocate more to reserves are characterized by having conservative traits, while species that allocate less resources to reserves should have acquisitive traits.
Methods. Free sugars, starch and total non-structural carbohydrates (NSC) were measured in leaves, branches, stems and roots in 85 tropical and temperate tree species in Colombia and Canada. We also measured SLA, Amax, dry matter content and nitrogen content in leaves, tissue density in stems and tree trunk diameter a breast height (DBH) in 3-5 individuals per species.
Results. Roots had the highest concentration of NSC and starch, while leaves had the highest concentration of free sugars. Stems had the lowest concentrations of NSC while branches were intermediate. Concentrations of free sugars, starch and NSC in stems decreased significantly with increasing SLA, Amax and LDMC. Yet, the relationships between leaf functional traits and carbohydrates in roots and branches were generally weak.
Conclusions. Species with 'acquisitive' leaf traits stored more carbohydrates in their stems than species with 'conservative' traits supporting our initial hypothesis. However, there were no clear relationships between functional traits and root carbohydrate concentrations suggesting that storage in these organs is somehow independent from the growth-survival trade-off that define the functional relationships between leaves and stems.

O72-08 – S72 *Free session: Functional traits in tropical ecosystems*
Thursday 23 June / 14:30-17:00 – Barthez

Rapid shift of reproductive modes as a driver of diversification in the neotropics: the case of poison frogs.

VACHER JEAN-PIERRE[1], FOUQUET ANTOINE[2], THÉBAUD CHRISTOPHE[1]
[1]Laboratoire EDB UMR 5174, Université Paul Sabatier, 31062, Toulouse Cedex 9, France
[2]Laboratoire écologie, évolution, interactions des systèmes amazoniens, Universtié de Guyane, CNRS Guyane, 97300, Cayenne, French Guiana

Background: Unravelling the origins of diversity and disentangling the multiple drivers of diversification in different parts of Amazonia (e.g. uprising of the Andes, fluctuation of climate, riverine barriers, etc.) has been challenging. Even though it has been hypothesised that current assemblages of species in the Guiana Shield mainly originates from dispersal events from the western and central parts of Amazonia, there are evidences that in-situ speciation also contributed to shape the diversity of this region. This is the case for Anomaloglossus, a Guianian endemic genus of frogs that displays contrasting life-history traits, e.g. some species have nidicolous tadpoles that complete their development solely on yolk reserves (endotrophic), whereas others carry the tadpoles to the water (phoresy) where they will feed and complete their development (exotrophic). We hypothesise that 1) frogs displaying nidicoly associated with endotrophy form a clade 2) acquisition of these characters provided advantages to colonise new niches during a favourable climatic period (warm and humid) and contributed to diversification within this genus.
Method: We generated complete mitogenomes and three nuDNA loci for 21 species of Anomaloglossus, and constructed a time-calibrated phylogeny with BEAST. We then inferred the ancestral states of both characters (endotrophy vs. exotrophy + nidicoly vs. phoresy) with a discrete traits reconstruction method.
Results: Our results yielded a well-resolved phylogeny of Anomaloglossus, with one clade gathering species of the Pantepuis region, and two clades in the lowlands of the Guianian area of endemism. Nidicoly associated to endotrophy characterises a derived phenotype from phoresy and exotrophy that have been acquired at least three times independently during the Miocene/Pliocene and Pleistocene.
Discussion: We suggest that first acquisition of endotrophy enabled colonisation of more humid regions of the Guiana Shield during the Miocene and Pliocene. Extended dry periods at the end of the Pliocene and during the Pleistocene could have been disadvantageous for nidicolous and endotrophic species, and such conditions certainly triggered a shift back to phoresy and exotrophy. Then, populations became isolated for long periods of time in forest refugia, thus leading to speciation.

P1-01 – S1 *Defaunation: a local process with global implications*
17:30 – 18:30 – Joffre Area (Level 1)

Asian elephant social structure and use of mineral licks in a Malaysian rainforest

NING HII, AHIMSA CAMPOS-ARCEIZ
The University of Nottingham Malaysia Campus, School of Geography, 43500, Kajang, Malaysia

Asian elephants (Elephas maximus) are intelligent animals with a complex social behavior that remains poorly understood, especially in the rainforests of Southeast Asia, where direct observation studies are virtually impossible. In these forests, however, elephants regularly visit mineral licks to supplement their diet, which presents an opportunity to study them using remotely-triggered camera traps. Here we present a study with the objectives of (1) assessing the feasibility of using camera traps to study forest elephants, (2) describing the social structure of elephants in a Southeast Asian rainforest, and (3) quantifying the use of mineral licks by our study population.
We used camera-traps to record videos of the elephants visiting a large mineral lick in Belum-Temengor Forest Complex, northern Peninsula Malaysia, for a period of 13 months. To identify individuals elephants we used features from the ears, body, and tail; we then created a database of known individuals and recorded their frequency of visits and association patterns with other elephants.
We obtained a total of 951 hours of elephant videos representing 284 elephant visits to the lick. We identified a total 78 individuals, including 26 adult and 9 subadult females, and 16 adult and 6 subadult males. Seven female social groups and four mother-calf units were identified with average group sizes of 6.4 ± 3.3 (SD) and 2.3 ± 1.5 individuals, respectively. Social groups visited the licks with a frequency of 14 ± 12 (range 1-33) times in the study period. Males visited the lick less frequently (5 ± 3 times).
Our results show that remotely triggered camera-traps can be used to study the social behavior of forest elephants visiting mineral licks in the forest. As expected, female social groups in the rainforest are smaller than those described for elephant populations in open habitats, especially in African savannas. We found a female-biased sex ratio (0.7:1), possibly as the result of poaching of males for ivory. The high number of individuals recorded visiting the lick and the high frequency of visitation, especially of certain groups, suggests that mineral licks are important resources for elephants in these forests and should be protected. This is the first quantitative study of elephant social organization in Southeast Asian rainforests.

P2-01 – S2 *Success of tropical legumes and traits that contribute to their dominance*
17:30 – 18:30 – Joffre Area (Level 1)

Hyperdominance in a seasonally dry tropical forest: The genus Poincianella in the Caatinga-forests of Brazil

MELANIE FORKER[1], PHILIP TAFARTE[2], VOLKER BITTRICH[3], ADAUTO RIBEIRO[4]
[1]Technical University Dresden, Forest Botany, 01069, Dresden, Germany
[2]Helmholtz Centre for Envirinmental Research, UFZ, 04318, Leipzig, Germany
[3]Unicamp, Botanical Garden, 13083-590, Campinas, Brazil
[4]Universidade Federal de Sergipe, Ecology and Conservation, 49100-000, São Cristóvão, Brazil

Poincianella pyramidalis (Tul.) L.P.Queiroz and other species of the same genus are so omnipresent in the region of the Caatinga-Biome, that their common name is "Caatingueira". Fabaceae have since long been recognized as the most important family in the Biome.
Our case study was conducted in Sergipe, Brazil, characterized by a megathermal semiarid climate (mean annual temperature: 26-28°C, precipitation: 500-700 mm/year). The severe drought in 2012 and 2013 emphasized the importance of research on sustainable land-use in SDTFs that withstand climate change. An earlier floristic survey in the same study area registered 174 species in 51 families of which the Fabaceae stand out with 29 species.
We sampled 40 relevés of 20x20m, recording species composition, DBH and height of all individuals with DBH >2.5 cm. Sampling design was stratified including two successional stages.
Poincianella pyramidalis is present in all vegetation types with the highest number of individuals and contributes with a high share to the total biomass, however its mean DBH is < 5 cm. It can grow as shrub or tree but usually shows multiple stems. The crown architecture has been documented with Close-Range Photogrammetry (n =10) in the young successional stage.
Species numbers and biomass are both significantly lower in the young successional stage, which is clearly dominated by Fabaceae. Clear-cutting for pasture impedes regrowth of near-natural Caatinga forests through depletion of late-successional species, even if they occur in the near environment. A further threat to the natural vegetation is the invasion of degraded areas by Prosopis juliflora.

P2-02 – S2 *Success of tropical legumes and traits that contribute to their dominance*
17:30 – 18:30 – Joffre Area (Level 1)

The interaction between pollinator size and staminodes presence on the rate of pollen removal and deposition in Bauhinia yunnanensis (Leguminosae: Caesalpinioideae)

MENGLIN WANG, SHUYIN HUANG, LING ZHANG
Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Key Laboratory of Tropical Forest Ecology, 666303, Mengla, China

Previous studies have shown that staminodes influenced pollination processes by preventing selfing, providing food for insect pollinators, attracting pollinators through their colors, and/or triggering pollination process by pollinators. However, most researches focused on large pileous ligulate staminodes in Penstemon, few studies care about general small simple staminodes. Here, we chose one climbing Chinese Orchid Vine, Bauhinia yunnanensis as a material to test the adaptive significances of these staminodes and potential effects on plant reproduction strategies and mating patterns. To this end, we conducted a field experiment where we removed staminodes of sexually mature flowers, and compared the relationships between staminodes and visiting frequency, pollen removal and deposition efficiency of two dominant pollinator species of B. yunnanensis. We found that B. yunnanensis displays remarkable intrafloral stamen differentiation-each flower generally consists of three stamens with large anthers and long filaments, and seven staminodes with tiny anthers with very short filaments. Staminodes removal significantly increased the visit frequency of Apis cerana, while the visit frequency of Amegilla zonata was reduced. Pollen removal rate was increased for both pollinator species when staminodes were removed. As such, staminodes in B. yunnanensis acted as a pollen dispensing mechanism reducing pollen amount which were removed by pollinator every single visit when there were so many pollinators. On the other hand, staminodes' presence increased pollen deposition by bigger size pollinator, A. zonata, while no changes by smaller pollinators, A. cerana, indicating that staminodes function in B. yunnanensis is influenced by size-dependent selection on bee body size. Our results suggest that presence and absence of staminodes influence pollinator composition of visiting pollinators and pollen removal and deposition rate, potentially influencing reproductive fitness of B. yunnanensis, then supporting pollen presentation theory.
Key words: Bauhinia yunnanensis; staminodes; pollinator behavior; pollen removal; pollen deposition

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P2-03 – S2 *Success of tropical legumes and traits that contribute to their dominance*
17:30 – 18:30 – Joffre Area (Level 1)

How far ecological niche influences organism morphology among related African species within the Guibourtia (Fabaceae) genus?

Félicien TOSSO[1], Olivier J. HARDY[2], Kasso DAÏNOU[3], Jeremy MIGLIORE[2], Alain HAMBUCKERS[5], Honore AGBAZAHOU[4], Charles DOUMENGE[4], Adeline FAYOLLE[1], Jean-Louis DOUCET[1]
[1]University of Liege, Gembloux Agro-Bio Tech, Forest Resources Management, Tropical Forestry, 5030, Gembloux, Belgium
[2]Université Libre de Bruxelles, Evolutionary Biology and Ecology Unit, Faculté des Sciences, 1050, Brussels, Belgium
[3]Nature+ asbl, Rue Provinciale 62, 1301, Wavre, Belgium
[4]Centre international de recherche agronomique pour le développement, Campus international de Baillarguet, 34398, Montpellier, France
[5]University of Liege, Behavioural Biology Unit, 4020, Liege, Belgium

Background: The ecological niche distance between pairs of related tree species can be a predictor for their morphological similarity under the assumption of niche conservatism, but the debate remains about the strength and occurrence of that link in nature. Moreover, there are many questions on the role of phylogenetic relationships in shaping ecological niche and morphological similarity among taxa. We addressed that issue with the African timber tree genus Guibourtia Benn. which includes 13 species, morphologically close, found in various habitats with different climate and soil conditions.
Methods: By combining, phylogenetic studies with morphological studies and ecological niche modeling methods, we used Mantel and Blomberg's tests to verify the hypothesis that morphologically similar African Guibourtia that occupy analogous ecological niches should be either considered as a unique taxon or represent related taxa.
Results: Our results highlighted that morphological traits were phylogenetically related (Mantel's $r=0.24$, $p=0.031$). We also found a signal that Guibourtia morphologically-close species occupy similar ecological niches (Mantel's $r=0.32$, $p=0.017$).
Conclusion
This result highlights action of selective forces along with neutral ones in shaping divergence between taxa, partly reinforcing the assumptions on the crucial role of past ice age fragmentations that isolated different populations in different environments. Consequently, the relationship between the ecological niche and phylogeny has been demonstrated, confirming phylogenetic niche conservatism hypothesis within the genus Guibourtia.

P3-01 – S3 *Model systems for studying the ecology and evolution of herbivore defence*
17:30 – 18:30 – Joffre Area (Level 1)

Branch architecture and canopy habitat structure: emergent proprieties from the trade-off between biomass allocation and herbivory

BÁRBARA CARVALHO BARBOSA[1], SÉRVIO PONTES RIBEIRO[2], GERALDO WILSON FERNANDES[3]
[1]MNCN-CSIC, Biogeografía y Cambio Global, E-28006, Madrid, España
[2]Federal University of Ouro Preto, Biodiversity, Evolution and Environment, 35400-000, Ouro Preto, Brasil
[3]Federal University of Minas Gerais, General Biology, 31270-901, Belo Horizonte, Brasil

Background: Studies on biomass allocation in the trees has described important for cost / benefit in plant development patterns. Changes in number, size, structure and spatial orientation of branches and leaves reflect how plants optimize the capture of light available. This study aimed understand how the angle of the branches of trees persistent and pioneer affects in biomass allocation between leaves and branches, and in which direction the changes in leaf characteristics arising from the angles, influence herbivory rate in these species.
Method: The study was conducted in a Semidecidual Tropical Forest with individuals in a population of Mabea fistulifera Euphorbiaceae (pioneer) and of Byrsonima sericea Malpighiaceae (persistent). Ten individuals of each species were selected, of which three extension units from branch were collected. From these were measured morphological characteristics, biomass and herbivory.
Results: The pioneer species have branches with lower biomass and greater length, leaves with smaller specific leaf mass and greater availability of foliar nitrogen in relation to persistent species. For pioneer species was found cost-benefit ratio between the angulation and biomass allocation. Branches with larger angles, which are in the lower part of the canopy, exhibited lower specific leaf mass with greater percentage of lost leaf area.
Discussion: We conclude that the ratio of the cost-benefit of low investment in leaf biomass in branches of larger angles is reflected therefore in greater herbivory in the least sclerophillous leaves of pioneer specie. On the other hand, B. sericea did not respond to the assumptions of cost-benefit ratio. This is due to the overall slope of the canopy in place where its occurs, which exhibited high values of dry mass for both its branches and leaves. In other words, the demand for biomass for branches and leaves on a sloping canopy is independent of the angle of the branches within the canopy, indicating that all structures must withstand mechanical stress caused by full inclination of the crown.

P6-01 – S6 *Free session: Experimental methods in tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Towards a burial threshold for tropical seagrasses Zostera muelleri and Halophila ovalis

CLAUDIA BENHAM, KATHERINE DANIELL
The Australian National University, Jenner School of Environment and Society, 2600, Canberra, Australia

Seagrass meadows are critical components of inshore habitats, but are undergoing rapid declines in many part of the globe. Across the Indo-Pacific, the primary driver of seagrass decline is port development and dredging, which can reduce water clarity and increase sedimentation. This paper focuses on Australia, where recent expansion in the coal and gas sectors has driven port development activity along much of the north eastern and west coasts, including in the Great Barrier Reef World Heritage Area. The speed and number of port expansions create an urgent need to understand the impacts of development on these critical species. However, there are currently few studies into the impacts of burial on seagrass growth and thresholds for burial are not established. This research examined the effects of burial on two tropical seagrass species, Zostera muelleri and Halophila ovalis. We find that shoot density in Z. muelleri also declines significantly at five millimetres of burial, and shoot density in H. ovalis is significantly reduced through burial by fine sand. The paper makes some recommendations for addressing these commonalities and differences in future research and management practice.

P6-02 – S6 *Free session: Experimental methods in tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

eDNA metabarcoding versus traditional methods for anuran surveys in the highly biodiverse Brazilian Atlantic Forest

CARLA M. LOPES[1], THAIS S. LOPES[2], ALICE VALENTINI[3], TONY DEJEAN[3], MARCIO R. C. MARTINS[2], KELLY ZAMUDIO[4], CÉLIO F. B. HADDAD[1]
[1]Universidade Estadual Paulista - UNESP, Zoology, 13506-900, Rio Claro, Brazil
[2]Universidade de São Paulo - USP, Ecology, 05508-090, São Paulo, Brazil
[3]Spygen, -, 73375, Le Bourget-du-Lac, France
[4]Cornell University, Ecology and Evolutionary Biology, 14853, Ithaca, USA

The detection of species through DNA traces left behind by organisms in the environment (eDNA) have been increasingly applied in aquatic systems. However, most of the aquatic eDNA survey studies conducted to date were performed in temperate zones, where environmental and climatic conditions favor the persistence of DNA traces longer than in tropical environments. In this study, we tested an eDNA methodology and compared the results with traditional monitoring methods to survey a frog community in the Brazilian Atlantic forest. Sampling was performed in four streams (ST) on the escarpments of Parque Estadual da Serra do Mar. Water samples were filtered at two sites per stream twice, for 20L and 60L of water. Three species were chosen as focal taxa for visual and call surveys: Cycloramphus boraceiensis, Hylodes phyllodes, and Hylodes asper. Sequence reads of 12S mitochondrial marker were filtered and annotated using the OBITools package. Statistical analyses were performed using R 3.2.3 software. In the final eDNA dataset we detected 17 sequences, corresponding to 10 taxa identified across the four streams. The species H. phyllodes was detected in all samples of eDNA, representing the highest proportions of sequence reads observed, ranging from 100% to 33.37%, yet this species was not detected by traditional approaches in ST1 and during the night in ST4. The species H. asper was not detected in ST2 using both eDNA and traditional approaches, the proportion of sequence reads range from 0 – 48.98%. Cycloramphus boraceiensis was not detected by eDNA in ST2, and in the site 2 of ST4 (proportion of sequence reads 0 – 37.54%), while for traditional approach it was only detected during the night surveys for ST1, ST3 and ST4. These results indicate these 3 species are the most common in this system of streams. A greater capacity of detection of the presence of species in the field was observed by eDNA approach compared to traditional methods of survey. Our results showed that filtering more water results in a higher number of positive PCR replicates and higher number of sequence reads for each species. However, the species recovered in samples of 20 L or 60 L, and from different sites within the same stream varied. These results indicate that filtering larger volumes of water helps to certify the presence of a species in the field, but the power of detection of different species increases if more than one eDNA sample is taken in the same aquatic system.

P6-03 – S6 *Free session: Experimental methods in tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Effect of Rubus control on arthropod abundance and diversity of Scalesia forest sites on Santa Cruz, Galápagos.

PAUL SCHMIDT YÁÑEZ[1], ARNO CIMADOM[2], SABINE TEBBICH[2], HEINKE JÄGER[3], LÉON BAERT[4], HENRI HERRERA[3], MATTHIAS WALTERT[5], CHRISTIAN H. SCHULZE[1]
[1]University of Vienna, Department of Botany and Biodiversity Research, 1030, Vienna, Austria
[2]University of Vienna, Department of Behavioural Biology, 1090, Vienna, Austria
[3]Charles Darwin Foundation, Charles Darwin Research Station, 0000, Puerto Ayora, Galápagos/Ecuador
[4]Royal Belgian Institute of Natural Sciences, Direction Taxonomy and Phylogeny, 1000, Brussels, Belgium
[5]Georg-August-University Göttingen, Department Conservation Biology, 37075, Göttingen, Germany

Invasive animal and plant species pose an increasing threat to biodiversity worldwide. This is particularly true for island ecosystems, which developed in isolation and are less resilient towards novel threats. A large number of different introduced species is currently threatening the endemic flora and fauna of the Galápagos Archipelago. One such case is the introduced bramble Rubus niveus. On Santa Cruz Island this species forms thickets of up to four meters height and is widespread in farmland as well as the endemic Scalesia peduncuata forests. High cover of R. niveus has led to significantly lower native plant species richness and cover, as well as to changes in the Scalesia forest structure. Management measures to control the R. niveus invasion threatening the last remnants of the Scalesia forest include the application of strong herbicides and mechanical control. These management measures by the National Park lead to a complete removal of the undergrowth. The aim of the present study was to evaluate the effect of these management measures on the native arthropod fauna, consisting of over 50% endemic species.
To quantify the impact of Rubus control in the Scalesia forest on Santa Cruz Island on diversity and abundance of arthropods, we sampled three study plots affected to a different degree by control measures: recent herbicide use (plot H1), herbicide use four years ago (plot H4) and without control measures, hence heavily invaded by R. niveus (plot NH). In each of these plots arthropods were sampled from the canopy foliage, moss on tree trunks and undergrowth vegetation.
Preliminary results show that management measures have a significant effect on the composition of arthropod assemblages (PERMANOVA: $R = 0.7$. $p < 0.001$). Further, species richness of arthropods sampled from moss was lower at H1 than at NH and H4 and arthropod richness of undergrowth vegetation was slightly lower in both plots with control measures (H1 and H4) compared to NH.
Our findings might be helpful to National Park authorities in adapting management measures to minimize the negative impacts on the native fauna. The Rubus control measures might not only have direct effects on the structure of arthropod assemblages, but also have an indirect impact on moss-dwelling species occurring on tree trunks, perhaps due to changes in adjacent microhabitats and microclimate (e.g. decreased humidity).

P8-01 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Expanding the role of protected areas as a conservation tool in Colombia

MARIA FERNANDA TORRES JIMENEZ, JULIETH SERRANO, MARIA CAMILA GÓMEZ-GUTIÉRREZ, KARINA BANDA, EUGENIO VALDERRAMA, JAMES RICHARDSON, JAVIER LUNA-CASTRO
Royal Botanic Garden Edinburgh, Tropical Diversity Science, EH3 5LR, Edinburgh, UK

Background: Colombia is the second most biodiverse country on Earth. Approximately 30% of this biodiversity is considered of high conservation interest due to its restricted distribution and exclusive occurrence, present only in the Colombian ecosystems. The high importance of Colombia's biodiversity lies in the confluence of unique species, biotas, and potential services these resources provide to the support of stable societies coexisting in harmony with the environment. In Colombia, areas of high biotic and/or cultural importance are delimited as public protected areas managed by the government or as privately owned protected areas. Both schemes face the challenge of preserving the Colombian biodiversity. This task must consider factors that could compromise its success, including social conflict, macroeconomic policies and climatic change. The complexity of the scenario is calling for diverse solutions to effectively conserve Colombia's biodiversity.
Methods: rbgeColombia aims to study the biogeography, evolution and conservation of the Colombian biomes whilst running an outreach programme promoting our research, which is being conducted in almost every biome including Páramo, and montane, dry, and lowland rain forests. Now it is time to jump the fence and land into the management of a protected area. Our objective is to enhance the value of this conservation unit in the biological and the social sense through the implementation of innovative approaches.
Results: These non-traditional approaches will integrate biological research, sustainable silvicultural practices and educational programmes. Research will include recent techniques for the study of the evolution, ecology and origins of Neotropical ecosystems; silvicultural practices will use low impact harvesting based on collective-long term use of resources and forest recovery, shifting agroforestry and landscape planning; and educational programmes will inform and promote the importance of biodiversity to local communities and neighbouring populations.
Discussion: The implementation of innovative approaches to the use of protected areas could decelerate the detrimental effect of human activities on biodiversity hotspots. Ultimately, this will create a bridge between academic research and local conservation. Thus promoting an efficient and novel way to manage protected areas within the complexity of the tropics and facilitating the adaption of tropical countries to climate change.

P8-02 – S8 *Free session: Land use, landscape ecology, and conservation*
7:30 – 18:30 – Joffre Area (Level 1)

Micro-topographic variation and water abundance create heterogeneous landscapes for dipterocarp seedlings on alluvial plains

MARGOVE JAMES
Ecosystem Management Group, ETH Zurich, Switzerland

Background: There is a tremendous array of diversity in tree species in the tropics, and a serious effort by scientists to understand how they all coexist. A seemingly flat alluvial plane actually displays substantial micro topographic variation in concave and convex forms and combined with intra annual variation in water abundance during wetter periods creates ephemeral ponds throughout the land scape. Flooding reduces oxygen in the soil, causing a switch to inefficient anaerobic respiration and photosynthesis to shut down. Water's patchy distribution presents tree seedlings tree seedlings with a highly heterogeneous environment in the early stages of life creating openings for a competitive advantage in those that are tolerant.
Methods: Our design contained 16 different species split equitably between 32 plots nested within 16 blocks and fully randomised positions 64 seedlings (2048 seedlings total). Each plot's micro-topography was mapped and linked together creating a single explanatory variable. Seeds we're sources directly from mothers accounting for any maternal effects, and a mixed effects model was used to analyse the data. Seedling census' were done every 3 month since December 2014.
Results: We find differences in the mortality of 16 dipterocarp species related to water abundance during the rainy period and during the subsequent dryer periods.
Conclusion: These micro processes acting on seedlings are influential in the maintenance of species diversity.

P8-03 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Can cloud forest species adapt to disturbances or are they doomed to an enforced disappearance? A case study

ALICIA LEDO, DAVID F.R.P BURSLEM
University of Aberdeen, School of Biological Sciences, AB24 3UU, Aberdeen, UK

Tropical montane cloud forests typically have high species endemism and biodiversity, but they are now one of the most endangered and vulnerable ecosystems in the world. Many tropical montane cloud forests play an important role in the hydrological cycle and maintain the natural flow patterns of the streams which originate in them.
The aims of this study were to identify the factors that determine patterns of tree species distribution and to assess the causes of changes in species composition and biodiversity in a tropical montane cloud forest in Peru. Our fundamental concern was to determine the resilience of these forests to changes in environmental conditions and habitat fragmentation.
To answer these questions, a pilot study was conducted in a montane cloud forest located in the north Peruvian Andes. The results suggest that different tree species coexist in a balanced equilibrium, which is habitat-driven for some species and dependent on interspecific interactions for others. We observed a reduction in species diversity at the forest edge and at lower elevations, along with a pervasive change in community structure towards species adapted to dryer conditions. Those observations may clead a change in the functions of the ecosystem, and affect ecosystem resilience.
We conclude that these cloud forests are suffering from pressure arising from fragmentation and climate change, resulting in changes to optimal micro-environmental conditions for maintenance of community structure and ecosystem function. Urgent action is needed to protect cloud forests from disappearance.

P8-04 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Anolis lizards as biocontrol agents along gradients of land-use intensification in tropical coffee agroecosystems

IVAN MONAGAN
University of Michigan, Ecology and Evolutionary Biology, 48104, Ann Arbor, USA

The relationship between biodiversity and ecosystem function has received much attention due to growing concerns around the negative impact of intensified land use in agricultural landscapes. Empirical and theoretical studies suggest biodiversity stabilizes ecosystem function, whereby functional diversity acts as a buffer for ecosystem processes amidst environmental disturbance. Several studies suggest that the presence of generalist predators leads to a decrease in the abundance of herbivorous pests, but our understanding of how these interactions vary across gradients of intensification and eco-geographic space remains poorly understood. In this study, I assess the functional response and biocontrol potential of a highly ubiquitous insectivour (Genus: Anolis) on the world's most important coffee pest, the coffee berry borer (Hypothalemus hampei). I conducted field surveys and laboratory experiments to examine the impact of land-use intensification on species richness and abundance of anoles, and the capacity of anoles to reduce berry borer infestations in mainland and island coffee systems. My results show that anoles significantly reduce coffee infestation rates in laboratory settings (Mexico, p=0.03; Puerto Rico, P=0.014), and are capable of consuming H. hampei in high quantities. Additionally, diversified agroecosytems bolster anole abundance while the application of pesticides nearly eliminates individuals from the genus entirely. The results of this study suggest that diversified agricultural landscapes play an important role in sustaining wildlife diversity, crop production and food sovereignty.

P8-05 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Effects of roads and trails on the vegetation, fruit availability and birds of an Atlantic Forest protected area in Brazil

BRUNA GONÇALVES DA SILVA, INGRID KOCH
Universidade Estadual de Campinas, Departamento de Biologia Animal, 13083-862, Campinas, Brazil

Background. The dynamics of gaps imposed by roads and trails can affect natural ecosystems and ecological processes. Our aim was to investigate the effects of types of pathways on the vegetation, fruit availability and frugivorous birds in the Brazilian Atlantic forest.
Methods. Data were gathered in three different types of pathways in forest, with varying widths and use – paved road (20m wide - high usage), dirt road (10m wide - low usage), touristic trail (2m wide - high usage) – and in a control area, in the Carlos Botelho State Park, a protected area in southeast Brazil. We established eight plots within each area. Plant communities were sampled on structure, composition, dispersal syndromes and successional categories. We compared fruit availability by means of the number of species and individuals bearing fruit, fruit production by syndromes and seasonality. For birds we sampled abundance, richness, composition and guilds (frugivorous and omnivorous), variables that were correlated to habitat features.
Results. In wider pathways there were more plants with low height and small diameter, a high proportion of pioneer and anemochorous species, and a higher number of species and individuals bearing fruit. The paved road had the highest production of anemochorous fruits and number of anemochorous fruiting species, and the production of zoochorous fruits was higher in the trail and the control area. Fruiting peaks occurred only in areas cut by pathways but not in the control area. The abundance, richness and composition of bird species were affected by type of pathway. The abundance of frugivorous was higher in the control area, and omnivorous in the paved road. Bird abundance and richness were positively correlated to fruit availability in the control area and dirty road, but not for paved road and trail. The use of pathways, the width, fruit availability, structure and composition of vegetation were important to explain differences found in bird composition.
Conclusion. Linear forest gaps are permanent in space and time and affect plant and bird communities. We strongly suggest that effects of pathways must be taken into account for successful management of protected areas, including better-informed planning and impact mitigation seeking the conservation of these communities.

P8-06 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Rapid population response to a chytrid outbreak stabilizes amphibian population

GRAZIELLA DIRENZO[1], REBECCA MCCAFFERY[2], KELLY ZAMUDIO[3], KAREN LIPS[1]
[1]University of Maryland, Biology, 20744, College Park, United States
[2]U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, 98362, Port Angeles, United States
[3]Cornell University, Department of Ecology & Evolutionary Biology, 14583, Ithaca, United States

Background: Spreading emerging infectious diseases is the inevitable consequence of globalization. The chytrid fungus, Bactachochytrium dendrobatidis (Bd), is implicated in the demise of hundreds of amphibian species worldwide, yet post-outbreak host population dynamics are poorly understood because it is challenging to document how host demography changes post-pathogen arrival when pre-outbreak data do not exist.
Methods: Using a unique system were pre-outbreak demographic data does exist, we analyzed five-years (2010–2014) of post-outbreak capture-mark-recapture data for a population of male Espadarana prosoblepon, and investigated (1) post-outbreak population size and growth rates, and (2) how host infection intensity affects survival probability. We developed a novel multi-state hierarchical Jolly-Seber model that adjusts for misclassifications of host disease states caused by laboratory error (i.e., qPCR).
Results: Between 2010 and 2014, we captured a total of 263 unique individuals a total of 482 times. Pre-Bd monthly survival probability (~92–94%) and post- Bd monthly survival estimates (~ 92–99%) of infected and uninfected individuals were nearly identical, suggesting a rapid eco-evolutionary adaptive response of hosts to Bd. Survival probability of infected hosts decreased as infection intensity increased, supporting the hypothesis that individuals cannot maintain normal skin function as a result of high pathogen burdens. And we found that individuals were gaining infections (monthly infection probability 84.5–99%) more often than losing infections (monthly recovery probability = 14.4–76.6%), suggesting that infected hosts are chronically infected. We also found that population size has stabilized at ~ 100 individuals per year, with no apparent increase or decrease in population growth rate.
Conclusions: Our results provide the first glimpse of hope for tropical amphibians suffering from Bd infections and help understand amphibian population dynamics post-Bd for conservation management.

P8-07 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Islands in the clouds: Small reserves are critical to conserve and restore tree biodiversity in Andean cloud forest.

SARAH JANE WILSON[1], JEANINE RHEMTULLA[2]
[1]McGill University, Geography, H4V2V4, Montreal, Canada
[2]University of British Columbia, Forestry, V6T1Z4, Vancouver, Canada

Montane tropical cloud forests, with their complex topography, biodiversity, high numbers of endemic species, and rapid rate of clearing are a top global conservation priority. However, species distributions at local and landscape scales in cloud forests are still poorly understood, in part because few regions have been surveyed. In particular, spatial variation among forests at the same elevation is seldom investigated, but critical for creating conservation and restoration strategies that work both ecologically and socially. In this study, we compare tree communities across multiple Andean cloud forests at similar elevations at the upper end of the 'mid-elevation diversity bulge' (1900-2250 masl). We surveyed trees in five ridge-top reserves in the Intag Valley, a heavily deforested region of the Ecuadorian Andes. We also ran focus groups and interviewed 120 households about their forest use and tree planting practices. We find that tree communities are distinct in primary forests located only 10 to 35 km apart, and that spatially closer forests are not more similar to one another. Although larger (1500 to 6880 ha), more intact forests contained significantly more tree species (108-120 species/0.1ha) than smaller (30 to 780 ha), potentially disturbed ones (56-87 species/0.1ha), each reserve had unique combinations of 'common' species, and contained high proportions of species not found in the others. Results suggest that protecting multiple cloud forest patches within this narrow elevational band is essential to conserve landscape-level tree diversity, and that even small forest reserves contribute significantly to biodiversity conservation. Moreover, although people use several primary forest species for timber, food, and medicine, they tend to plant mixtures of useful species that are distinct from the combinations found in primary forests. We demonstrate that understanding both species distributions and local use preferences are critical for creating community-based conservation and restoration projects in montane forests that work from ecological, economic, and cultural perspectives.

P8-08 – S8 *Free session: Land use, landscape ecology, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Art-science interaction: imagining the tropics otherwise

ERNA VON DER WALDE
Mas arte mas accion, Trustee, 111321, Bogota, Colombia

The foundation Más arte mas acción (More art more action) has created a "protected area" in the Colombian region of Chocó, one of the most biodiverse regions in the world, where we have been working for over ten years. With the participation of guest artists, activists, academics, journalists, and members of the local communities, we have explored environmental and related issues, designing projects around water, sustainability, food sovereignty, consumption, and technology.
Now we are joining efforts with scientists from the RBGE who work locally in Colombia to address more concretely the issue of conservation of tropical biodiversity. This is a pressing problem and one we consider should be seen as a priority on the agenda in Colombia now that a peace agreement between the government and rebel forces is on the way.
The tropical regions of the Americas have a long history of colonisation and depredation, paired with a vision of tropical fauna and flora as obstacles to be removed in order to create more manageable and "civilised" landscapes under the banner of progress and development.
The presence of armed actors in some of the more "hostile" Colombian landscapes has kept many large extractivist projects from penetrating them with full force. Thus, ironically, the conflict that is now being put to rest unwittingly contributed to the preservation of the country's rich biodiversity.
Our explorations on the interaction between art and science involve thinking how to see the threatened landscapes differently, how to imagine the tropics otherwise, and how to engage citizens and governments in their protection and conservation.
We shall address some questions regarding the traditional ways in which art and science have collaborated, and suggest some ways in which scientific knowledge, interdisciplinary work and the intervention of local knowledge and artistic ways of seeing can contribute to raise awareness and, ideally, shift the "common sense" about conservation and biodiversity.

P10-01 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Using herbarium records to explore the ecological specialization between closely-related tree species in tropical Africa

ANAÏS-PASIPHÉ GOREL, JEAN-LOUIS DOUCET, ADELINE FAYOLLE
Univ. Liège - Gembloux Agro-Bio Tech, BIOSE, Gestion des Ressources forestières et des Milieux naturels, Foresterie tropicale, 5030, Gembloux, Belgium

Background: Tree hypothesis are invoked to explain species distribution and evolutionary history of tree clades in tropical Africa: 1) The forest refuge hypothesis postulates that contractions of lowland forests during the climatic oscillations of the Pleistocene could have driven allopatric speciation between fragmented populations; 2) The ecological gradient hypothesis states that environmental gradients promote parapatric speciation; 3) The vanishing refuge hypothesis reconciles the two previous hypotheses and postulated a diversification process through climate-driven habitat fragmentation and exposure to new environments. Disentangling the respective influence of environmental and historical factors requires information on phylogeny, as well as information on geography and the environmental space used by species. In this study, we aimed to determine the environmental factors constraining the distribution of African tree species in order to explore ecological divergence and speciation processes.
Method: We focused on three African Erythrophleum species (Fabaceae, Caesalpinioideae) that are economically and socially important, providing timber and non-timber resources. Erythrophleum ivorense, Erythrophleum suaveolens and Erythrophleum africanum also show contrasted distributions in Africa. To determine species climatic niche, we used a combination of species presence data gathered from 606 herbarium records and environmental factors (19 BIOCLIM variables). We used Species Distribution Models (SDM, MaxEnt algorithm) in combination with similarity metrics to quantify the degree of niche divergence between species.
Results: We showed that the distribution of Erythrophleum species are substantially determined by climate (especially annual rainfall and temperature range) and support the ecological gradient hypothesis. Moreover, the main traits (e.g. wood density and leaf area) and growth rates previously reported among Erythrophleum species confirmed a differential adaptation to drought.
Conclusion: Herbarium data provide valuable information on the distribution of species over the whole range. In tropical regions where extensive inventories data are extremely rare, herbarium records in combination with presence-only SDM offer opportunities to explore speciation processes.

P10-02 – S10 *Sleeping tropical beauties, the importance of herbarium- and xylarium-based scientific research for the ecology and management of tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Photoperiodic control of phenology in the deciduous bromeliad Pitcairnia heterophylla

LUIS DIEGO RIOS, ALFREDO CASCANTE-MARIN
Universidad de Costa Rica, Escuela de Biologia, 11501, San Jose, Costa Rica

Background: Seasonal variation in day length is a proximate cause in the phenological response of temperate plants, but evidence of a similar role in tropical species is scarce. In this study we examined the influence of photoperiod on the reproductive phenology of an epiphytic and deciduous bromeliad, Pitcairnia heterophylla in Costa Rica.
Methods: For three years (2011, 2012 and 2016) we monitored the population phenology (n = 157) in a premontane forest in Costa Rica. The reproductive phenology of the species was analyzed throughout its range (central Mexico to Peru) using herbarium specimens. In addition, a greenhouse experiment exposed 10 plants to long-day conditions (12.5-13 h daylight-1), and 10 to short day conditions (11.5 h daylight-1) for four months. As a control we used the phenological data from 157 individuals in the field under natural daylength conditions. Finally, we performed hand pollination experiments and video recording of floral visitors to determine the breeding system and the potential pollinators.
Results: Inflorescence bud development started early in November. Leaf shedding began shortly after and peaked by December, flowering peaked six weeks later during the dry season (February). Along its continental distribution, populations above the Equator flowered between October and March while populations below the Equator flowered between May and September. In both cases, flowering occurred after the autumnal equinox when day length start decreasing. In the greenhouse plants exposed to long-day conditions didn't show any sign of phenological change; while those exposed to short days, began shedding their leaves two weeks after the exposure. Flowering began three months after the exposure. The species is self-compatible, capable of autonomous pollination and visited by three species of hummingbirds.
Discussion: Our results suggest that the seasonal decrease in day length induces leaf shedding and bud development in P. heterophylla. Leaf shedding might function as a mechanism to reallocate resources for reproduction. Also, as P. heterophylla is self-compatible and capable of autonomous self-pollination, leaf shedding may increase flower visibility and accessibility to hummingbird pollinators promoting outcrossing rates.

P12-01 – S12 *Free session: Plant physiology, and ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Form and function of leaf venation networks in tropical forests

AGNE GVOZDEVAITE[1], BENJAMIN BLONDER[1], IMMA OLIVERAS[1], DAVID MARTINI[2], NORMA SALINAS[1], YADVINDER MALHI[1]
[1]University of Oxford, Environmental Change Institute, OX1 3QY, Oxford, UK
[2]Wageningen University, Plant Ecology and Nature Conservation Group, 6708 PB, Wageningen, Netherlands

Background. Recent research has been attempting to quantify the role of leaf venation traits in regulating plant functioning. Identifying such relationships has been challenging and use of empirical data analysis to understand the form, function and distribution of these traits is still very sparse. Therefore, we explore the relationships among venation traits, climate and species specific features. We hypothesise that due to environmental filtering the variation and distribution of venation traits varies with climate, specifically, with differing hydraulic environments, and species interactions.
Method. We sampled more than 160 species occurring in eleven tropical forest communities along rainfall gradient in Ghana and Brazil ranging from 1200mm to 2200mm annually. The values for venation traits studied (vein density, number of free ending veins, number of loops, areoles and vein branching angles) were extracted from microscopic images of chemically cleared leaves. To fully understand the variation of these traits we related them to leaf morphology, phenology, successional guilds as well as environmental variables.
Result. Our findings suggest of strong empirical venation-precipitation links. Using linear regression models, we found that vein density was positively correlated with mean annual rainfall. It appears that distribution of venation trait values due to environmental filtering is linked with certain water-use or carbon-gain strategies. Additionally, we found that leaf shape and increases in the complexity of leaf perimeter were associated with increases in vein density.
Discussion/conclusion. High levels of plasticity observed in measured venation traits within individual trees and among forest communities suggest multiple functional and environmental relationships. These trait-environment linkages demonstrate complex nonlinear forms, therefore, it is important to consider the effects of multiple environmental and physiological variables that could also correlate with precipitation, such as soil fertility or levels of shading. The findings of our study contribute towards better understanding of plants sensitivity/tolerance to drought.

P12-02 – S12 *Free session: Plant physiology, and ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Jatropha curcas microbiome recruitment and composition in Panama

KIMBERLY MIGHELL[1], KRISTIN SALTONSTALL[2], SUNSHINE A. VAN BAEL[1]
[1]Tulane University, Ecology and Evolutionary Biology, 70118, New Orleans, USA
[2]Smithsonian Tropical Research Institute, Molecular Biology, 34002, Panama City, Panama

Background: Soil is the principle source of bacterial symbionts of plants. Select bacteria colonize the rhizosphere and subsequently the endosphere, where they reside as endophytes. Soil chemistry, edaphic factors, biogeography and host biology all influence this microbiome. Jatropha curcas (Euphorbiaceae) is a drought-tolerant biodiesel crop plant that is native to dry, tropical Central America. We investigated how soil edaphic factors and biogeography affect Jatropha's endophytic and rhizosphere community in Central Panama.
Methods: We transplanted sterile J. curcas seedlings into three sites along a 125km transect. The sites differed in mean precipitation, and each site had unique soil chemistry and soil history. Leaves, roots, and rhizosphere samples were collected from the seedlings after growing in the soil at each site for ten weeks. We extracted the DNA for all samples. For a selection of roots and rhizosphere, we also extracted RNA and created cDNA libraries of the 16S gene. We sequenced the 16S community on the Illumina MiSeq platform and analyzed the results using Qiime.
Results: Root, leaf and rhizosphere bacterial communities were all distinct. Leaf and root communities were dominated by Proteobacteria, with leaves containing mostly Alphaproteobacteria and roots containing roughly even mixtures of Alphaproteobacteria and Betaproteobacteria. The rhizosphere was dominated by Proteobacteria and Acidobacteria. The cDNA library of the rhizosphere showed that many different groups, principally Acidobacteria, were present in lower abundances in the cDNA library as compared to the DNA library. Ordination revealed that site was a significant factor driving community clustering, with sites experiencing similar rainfall being more similar, despite differences in land use histories and soil nutrient levels.
Conclusions: We conclude that climatic factors have a profound effect on the symbiotic community of J. curcas. Bacterial 16S presence and activity differed, demonstrating that certain bacterial orders are more metabolically important than previously thought. As J. curcas is a drought tolerant plant, the symbiotic community may play a profound role in mitigating its stress tolerance. By comparing this work to plant performance data and bacterial community functionality, we can predict how different bacterial communities may act within the host and offer insight into how soil can be managed to sustainably increase productivity of J. curcas agriculture.

P12-03 – S12 *Free session: Plant physiology, and ecology*
17:30 – 18:30 – Joffre Area (Level 1)

The influence of seed size and environment on seedling growth of the tropical tree Faramea occidentalis

EUGENE SCHUPP
Utah State University, Wildland Resources, 84322-5230, Logan, USA

Background: Under controlled conditions larger seeds generally produce larger seedlings. However, the effects of seed size may be sensitive to environmental variation. Consequently, the significance of seed size variation for individual fitness will depend to a large extent on the relative impacts of seed size and environment on seedling vigor. In many forests, treefall gaps are the major, though not only, source of environmental variation influencing seedling growth. In this experimental study I simultaneously investigated the effects of seed size and environmental variation on early seedling growth.
Method: On Barro Colorado Island, Panama, I planted Faramea occidentalis seeds spanning a wide range of mass in 4 microhabitats: (1) crown and (2) trunk zones of treefall gaps, and beneath (3) conspecific and (4) heterospecific canopies in the understory. At 6, 9.5, 41.5, and 67 months I measured stem length and basal stem diameter, and counted the number of leaves. At 6 months I also harvested a subset of seedlings for dry mass. I used ANCOVA with microhabitat as the categorical variable and seed mass as the covariate. The microhabitat x seed mass interaction was non-significant in all cases so slopes were homogeneous and ANCOVA was valid.
Result: Seedling mass at 6 months was significantly affected by microhabitat and seed mass, which together explained about 72% of the variance. Mass was greater in gaps than understory, but did not differ between trunk and crown zones or between conspecific and heterospecific canopies. Although highly significant, the microhabitat effect did not obscure the seed size effect. When treatments were lumped, a regression of seedling mass on seed mass was highly significant. Results were similar for other measures of growth; growth increased with seed size and was greater in gaps than in understories. Through 41.5 months 1 or more measure of growth increased significantly with seed size and were greater in crown than trunk zones of gaps. By 67 months, sample sizes were too small to detect any important differences.
Conclusion: In field conditions seed size had a significant influence on seedling size >3 years after emergence, an unusually long time for an effect to be evident. Although microhabitat had highly significant effects on seedling size throughout, the effect was not strong enough to overcome the seed size effect at 6 months. Seed size clearly has a major effect on early growth in this tree species.

P12-04 – S12 *Free session: Plant physiology, and ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Variation in stomatal density of Bursera simaruba, a dominant tree species of tropical hardwood hammock forest across a habitat gradient in the Florida Keys

SURESH SUBEDI, MICHAEL ROSS
Florida International University, Earth and Environment, 33199, Miami, USA

Tropical hardwood hammock forests are found on coastal ridges in the Florida Keys. Trees in these forests depend on groundwater as their main source of water. Trees at lower elevations have more access to the ground water due to their proximity to the water table, while trees at higher elevations are far away from water table and go through drought stress. However, trees at very low elevations frequently flood, and if the ground water table is brackish or saline, they may have to cope with salt stress as well as flooding. We examined how stomatal density and size in one of the dominant species (Bursera simaruba) in these forests co-vary with elevation and ground water salinity. Eight study sites that vary in elevation and ground water salinity were chosen across the Florida Keys. In each site, three mature trees were randomly selected and five leaves per tree were collected for stomatal analysis. Leaf imprints were made and stomatal length, width, and density were measured in digital images under a compound microscope. Leaf carbon stable isotope ratio (d13C) of each tree was determined to infer the underlying variation in physiological stress of each tree.
Stomatal density varied widely among sites. The lowest mean stomatal density was found in Lower Keys sites with fresh ground water, while sites with elevated ground water salinity had the highest stomatal density. Across the elevation gradient, the stomatal density pattern was U-shaped: slightly greater at very low elevations, decreasing slowly toward mid-elevations, then increasing more sharply at higher elevations. A positive correlation between stomata density and ground water salinity was found. Furthermore, a significant positive correlation between d13C and stomata density indicates that stomatal density may be associated with water use efficiency. Observed significant negative correlation between stomatal density and size may be associated with leaf area development under stressful environment. Overall, the results showed that B. simaruba exhibits a degree of stomatal trait plasticity in response to environmental changes.

P13-01 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
17:30 – 18:30 – Joffre Area (Level 1)

Assessment of fine scale population genetic diversity and regeneration in Congo Basin logged forests

EVRARD QUENTIN[1], DAÏNOU KASSO[2], HARDY OLIVIER[3], DUMINIL JÉRÔME[4], LAGOUTE PAUL[5], BRACKE CHARLES[2], DOUCET JEAN-LOUIS[1]
[1]Gembloux Agro-Bio Tech / Université de Liège, TERRA & BIOSE, 5030, Gembloux, Belgium
[2]Nature+, WINSTAR Park, 1301, Wavre (Bierge), Belgium
[3]Université Libre de Bruxelles, Service Evolution Biologique et Ecologie, 1050, Brussels, Belgium
[4]Bioversity International, Genetic Resources and Crop Evolution, 472/9, Maccarese, Italy
[5]Pallisco, SARL, 478, Douala, Cameroon

Background: In the Congo Basin most of the light-demanding timber tree species display a deficit of natural regeneration which is a major handicap for sustainable production and certification. Whilst the majority of scientists investigate abiotic and biotic factors explaining that pattern, we hypothesize that tree population density or individual spatial isolation may also affect the tree fitness through inbreeding. In this study, we integrate ecological and genetic approaches to characterize the regeneration potential of a set of priority timber species by (i) estimating pollen dispersal distances at various tree population densities, and (ii) evaluating the impact of increasing spatial isolation on mating characteristics and tree fitness. The ultimate goal is the proposal of minimum population density that prevents inbreeding consequences.
Method: This ongoing study focuses on 10 timber species (Pericopsis elata, Milicia excelsa, Baillonella toxisperma, Entandrophragma cylindricum, E. utile, E. angolense, E. candollei, Afzelia bipindensis, Erythrophleum suaveloens, Terminalia superba). The data collection was carried out in the logging concession granted to Pallisco in Cameroon.
We established two 400-ha plots, where all individuals (DBH > 10 cm) of the target species were inventoried and mapped. A sample of leave or cambium was collected for each of these individuals, as well as for seedlings to characterize patterns of gene flow using genetic tools (nuclear microsatellites). Dispersal agents were identified by direct observations and camera traps. Germination success was characterized in nursery for seeds collected on trees under an increasing isolation gradient.
Results: Main dispersal agents (wind, bat, rodent) and predators (rodent) were identified for all the species. The gene flow and germination data is still being analyzed and the main results will be presented in the poster.
Conclusion: Our data will allow characterizing the reproductive biology of a set of important timber species from the Congo basin. These information will strengthen sustainable forest management and the application of certification by adjusting harvesting norms through the use of scientifically-relevant data. In particular, we will tentatively define a maximum distance to be maintained between two adults to allow a qualitative reproduction.

P13-02 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
17:30 – 18:30 – Joffre Area (Level 1)

Wildlife: comparison between three contrasted land use types in Cameroonian tropical forests

SIMON LHOEST[1], LAETITIA DELBEKE[1], KASSO DAÏNOU[1], JEAN-LOUIS DOUCET[1], MARC DUFRÊNE[2], OLIVER FANKEM[3], FRANÇOIS VERHEGGEN[4], ADELINE FAYOLLE[1]
[1]Gembloux Agro-Bio Tech, University of Liège, Tropical Forestry, Management of Forest Resources, TERRA & BIOSE, 5030, Gembloux, Belgium
[2]Gembloux Agro-Bio Tech, University of Liège, Biodiversity and Landscape, 5030, Gembloux, Belgium
[3]Zoological Society of London, Research, Surveillance and Monitoring, 4558, Yaounde, Cameroon
[4]Gembloux Agro-Bio Tech, University of Liège, Functional and Evolutionary Entomology, 5030, Gembloux, Belgium

Background: Changes in land use have been identified as the main threat for biodiversity in the tropics. In addition to agricultural deforestation and other impacting human activities, poaching and hunting significantly affect tropical biodiversity, and this has led to an unprecedented decline of animal populations. Therefore, it is essential to assess the impact of land management on biodiversity. In this study, we aim to compare biodiversity levels between a protected area, a FSC-certified forest concession and community forests managed by local populations.
Method: The study was conducted in South-Eastern Cameroon in 2015 and early 2016. Two indicator taxa, recognized for their forest regeneration services, were selected: mammals and dung beetles. For mammals, direct and indirect signs of presence were counted along more than 660 kilometers of trails. Species richness and abundances of dung beetles in each type of land use were estimated by using a total of 52 pitfall traps checked after 48 hours. In addition, the forest structure was characterized by: (i) the tree density, (ii) the basal area obtained from previous floristic inventories and (iii) canopy openness measured with hemispherical photographs.
Results: The data are still being analyzed and results will be presented in the poster. Species richness and abundances will be compared between the three land uses and correlation between mammals and beetles densities will be evaluated. The influence of forest structure variables will also be tested.
Conclusion: Despite the presence of fauna in the study areas, the massive depopulation observed across the Congo basin could impact drastically forest dynamics. It is then essential to inventory and manage animal populations in African tropical forests. Ecological services provided by both large mammals and dung beetles are meaningful, especially for seed dispersal and forest regeneration. The role of the three studied land uses in preserving biodiversity and ecological services will be compared.

P13-03 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
17:30 – 18:30 – Joffre Area (Level 1)

Stopping Poaching Activities in Nyungwe Forest National Park (NNP): Biodiversity Conservation and Human-Wildlife Conflicts

Joseph TUYISHIMIRE, John MUGISHA
University of Rwanda, Center for Geographic Information Systems and Remote Sensing (CGIS), 212, Huye, Rwanda

Even if integrated conservation activities are claimed to be the goals achieved by NNP managers, illegal activities such as animal poaching are still going on inside the park. Through interviews with ex-poachers and intensive field work inside the park to identify poaching signs, this study assessed the effectiveness of conservation measures to the reduction of animal poaching activities and the improvement of the livelihood of neighbouring communities. Ex-poachers were characterized by a high rate of illiteracy and large families. The main causes of poaching consisted of poverty and ignorance about the importance of the park. Other causes consisted of bad habit, resistance to change, and search for meat. Methods of poaching consisted of snares and traditional weapons. The most targeted animals were large mammals consisting mainly of duiker (Cephalophus sylvicultor) and wild boar which were poached for both sale and subsistence purposes; and small mammals (mainly Porcupine and giant rat) which were poached for subsistence purpose. After poaching was prohibited, none of the respondents is still relying on poaching as a source of income, but agriculture became the major activity. Most of income generating activities are carried out in cooperatives and the fact that a large proportion of people did not join them yet was at the same time the result of ignorance and the cause of poverty. The current study encourages awareness raising and the increased support to cooperatives; while education of children at school age will help to block the transmission of poaching techniques from parents to children.

P13-04 – S13 *Biodiversity conservation in a conflicting context – The case of the Congo basin*
17:30 – 18:30 – Joffre Area (Level 1)

The relationship between species diversity and aboveground carbon storage is taxon-specific

FREDERIK VAN DE PERRE[1], MICHAEL R. WILLIG[2], STEVEN J. PRESLEY[2], ELIZABETH KEARSLEY[3], HANS VERBEECK[3], PASCAL BOECKX[4], ANDRÉ DE KESEL[5], DRIES VAN DEN BROECK[5], MYRIAM DE HAAN[5], BART WÜRSTEN[5], STEVEN JANSSENS[5], OLIVIER LACHENAUD[5], PATRICK GROOTAERT[6], MAURICE LEPONCE[6], STIJN COOLEMAN[7], HERWIG LEIRS[1], STEVEN DESSEIN[5], ERIK VERHEYEN[6]
[1]University of Antwerp, Evolutionary Ecology Group, 2020, Antwerp, Belgium
[2]University of Connecticut, Department of Ecology & Evolutionary Biology, 06269-4210, Storrs, United States
[3]Ghent University, Computational & Applied Vegetation Ecology, 9000, Ghent, Belgium
[4]Ghent University, Isotope Bioscience Laboratory, 9000, Ghent, Belgium
[5]Botanic Garden Meise, Botanic Garden Meise, 1860, Meise, Belgium
[6]Royal Belgian Institute for Natural Sciences, OD Taxonomy and Phylogeny, 1000, Brussels, Belgium
[7]Royal Museum for Central Africa, Vertebrates, 3080, Tervuren, Belgium

The preservation of forest carbon stocks is a key strategy in the battle against climate change. The UN-REDD+ program proposes to offer incentives for developing countries to reduce national deforestation rates and associated carbon emissions. These incentives could potentially mitigate climate change and at the same time conserve biodiversity. However, it remains uncertain whether preserving carbon stocks will automatically safeguard biodiversity. In many studies, biodiversity is positively (but weakly) associated with the amount of carbon stored in the ecosystem. This relationship is however geographically variable, and even reverses in some regions. Furthermore, most studies have evaluated relatively few taxa.
We analyzed the relationships between species diversity of a wide range of taxa (small mammals, birds, ants, flies, trees, lichens, slime moulds and mushrooms) and aboveground carbon in the UNESCO Biosphere reserve at Yangambi, Democratic Republic of Congo. To correct for differences in sample completeness, we used coverage-based standardization. We quantified three orders of diversity based on Hill numbers (species richness, exponential of the Shannon index, and inverse Simpson diversity). The relationship between each order of diversity and aboveground carbon was evaluated using orthogonal polynomial regression, including linear and quadratic components.
The diversity of small mammals, ants, bark-inhabiting lichens and mushrooms was not related to aboveground carbon. Only trees and leaf-inhabiting lichens showed a positive relationship, whereas flies showed a negative correlation. Bird diversity was lowest at intermediate levels of carbon (i.e., a U-shaped relationship).
Previous studies considering few species groups may have yielded incomplete answers to the seemingly complex relationship between biodiversity and carbon storage. Our study demonstrates that the relationship of biodiversity with carbon storage is taxon specific. Negative relationships between biodiversity and carbon storage were observed rarely, suggesting that carbon conservation programs such as UN-REDD+ may have little adverse effect on species diversity. To more comprehensively evaluate the effect of carbon stock on biodiversity, our future research will explore the relationships between phylogenetic and functional diversity and carbon storage.

P14-01 – S14 *Mapping diversity: from gene to system*
17:30 – 18:30 – Joffre Area (Level 1)

Biased views of biodiversity caused by differential sampling efforts in New Caledonia

MARAM CAESAR, PHILIPPE GRANDCOLAS, ROSELI PELLENS
Institut de Systématique, Evolution, Biodiversité, ISYEB - UMR 7205 CNRS, UPMC, EPHE. CP 50, Muséum national d'Histoire naturelle, 75005, Paris, France

Biodiversity hotspots are very often defined in term of raw species richness, endemism and extinction risk. Although specific richness informs about the total number of species occurring in a place, its suitability for comparing sites can be questioned, particularly if it is based on non-standardized sampling effort. From the perspective of providing guidelines for biodiversity conservation protecting species rich sites is always a good option. The great danger, however, relies in underestimating the biodiversity of some sites just because they were less studied. We examine this problem in New Caledonia, a biodiversity hotspot characterized by remarkable levels of microendemicity of its fauna and flora. Our aim is to evaluate how samples are distributed in space and how they influence our perception of biodiversity.

To perform this analysis we used a representative dataset of 1149 animal species studied in a series entitled Zoologia Neocaledonica, published by Muséum National d'Histoire naturelle, Paris in 8 volumes, 2497 pages, from 1988 to 2014. This publication is especially dedicated to the descriptions of species, revisions of genera, and to reports on the natural history of terrestrial and freshwater animals occurring in New Caledonia. We built a database with the systematic occurrence of these species, and completed the information about their distribution with an exhaustive search in the literature.

Our results show that accessibility is the main factor determining the raw number of species of a site, so indicating a higher diversity in areas near the roads, close to main rivers, and, surprisingly, on the top of mountains which are attractive locations accessible by helicopter. This illustrates how basic factors related to sampling effort strongly contribute to provide a biased view of the biodiversity distribution in space, calling attention to the need of assessments of bias in any attempt of area prioritization for land use and biodiversity conservation.

P14-02 – S14 *Mapping diversity: from gene to system*
17:30 – 18:30 – Joffre Area (Level 1)

Do collection data allow knowing the actual distribution of an endemic species in the Brazilian Atlantic rainforest?

VITOR DIAS TARLI, PHILIPPE GRANDCOLAS, ROSELI PELLENS
Museum National d'Histoire Naturelle, ISYEB- UMR 7205 - CNRS, MNHN, UPMC, EPHE, 75005, Paris, France

Natural history collections represent an important source of information for the development of biodiversity science, as they shelter specimens and associated data resulting of random and sparse biodiversity explorations along 300 years. In this period of intensive habitat destruction and massif species extinctions, collection data are often critical to understand organisms' distribution, as, for example, they can inform about species occurrence in areas where habitats have been severely transformed by human action.

Here we study this problem through the comparison of distribution models obtained either with historical data found in collection or with data obtained through targeted sampling. Targeted sampling was specifically designed to verify the extent and limits of distribution, and to include several phytophysiognomies of the biome as well as secondary forests and adjacent areas with diverse land uses. The study focuses on cockroaches of the genus Monastria endemic of the Brazilian Atlantic Forest. They occur from the Northeast to Rio Grande do Sul (from 03° to 30° S in a surface longer than 3000 km) and from the Atlantic coast to the furthest western limits of the Atlantic forest such as Misiones (Argentina) and Asuncion (Paraguay). Specimens of Monastria were found in collections of 11 museums, as a result of erratic accumulation during 200 years. Our analyses indicate that both datasets have an excellent performance in MaxEnt models. The AUC was 0.9429 and 0.9381, for collection and directed sampling respectively. Both models indicate that «mean diurnal range in temperature» is the variable that most contributed to the SDM, with 31.1% and 29.2%, respectively, and a high overlap of the potential distribution area (I=0.92). In spite of that, collection data markedly underestimates the distribution indicating an area of only 67% of that estimated with the direct sampling, particularly omitting important areas of occurrence in the extreme south and northeast. This much lower sensitivity seems to be a result of strong aggregation of the distribution points, as shown by the Z scores of "Average Nearest Neighbor" test (Z= -5.89 p= 0.0000 vs Z= -2.29 p=0.0220), even if the total number of points of collection are more than two times higher that of the direct sampling. These results go along with previous estimations with modeled datasets for plants, indicating a general tendency of underestimating potential distribution areas with collection data in SDMs.

P15-01 – S15 *Ecosystem ecology of african forests*
17:30 – 18:30 – Joffre Area (Level 1)

Variation of leaf gas exchange and leaf water potential among ecological guilds along wet-dry gradient in Ghana

THERESA PEPRAH[1], STEPHEN ADU-BREDU, IMMA OLIVERAS MENOR, MICKEY BOAKYE, SAM MOORE, YADVINDER MALHI
[1]Forestry Research Institute of Ghana, Forest Improvement and Productivity, UP, Kumasi, Ghana
[2]Forestry Research Institute of Ghana, Biodiversity Conservation and Ecosystem Service, UP, Kumasi, Ghana
[3]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, United Kingdom
[4]Forestry Research Institute of Ghana, Forest Improvement and Productivity, UP, Kumasi, Ghana
[5]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, United Kingdom
[6]Oxford University, Environmental Change Institute, OX1 3QY, Oxford, United Kingdom

The tropical African forest is understudied in terms of ecosystem function and its links to ecosystem composition and diversity. The aims of this study are to determine the seasonal variation in photosynthesis and leaf water potential among species functional groups along wet-dry gradient in Ghana. Leaf gas exchange, predawn and midday leaf water potential were measured on selected trees grouped into ecological guild status of pioneers, non-pioneer light demanders (NPLD) and shade bearers in three ecological zones in Ghana. Different ecological guilds behaved differently with regard to seasonality for the transition forest of Kogyae, in the forest-savannah transition zone of Ghana. Both sun and shade leaves behaved similarly in the respective ecological guilds. Pioneer species exhibited the highest maximum photosynthesis (AMAX) in the early rainy season, followed a decreasing order by minor and major rainy seasons. With the shade bearers, the AMAX values for the minor and early rainy seasons were similar and smaller than that of the major rainy season. The sun leaves exhibited higher AMAX in the early and minor rainy seasons than the shade leaves in the entire ecological guilds at Bobiri, in the moist semi-deciduous forest zone. However, the shade leaves generated higher AMAX during the major rainy season. A very high value was exhibited in the major rainy season than the other two seasons for all the ecological guilds. At Ankasa, in the wet evergreen forest zone, the values for both the shade bearer tree species and NPLD species were higher in the major than in the minor rainy season. Predawn water potential exhibited seasonality at Bobiri. The highest occurred in the major rainy season for the pioneer and NPLD species, and in the minor season for the shade bearers. Similar seasonal trend occurred in the midday water potential for all the ecological guilds. The predawn water potential at Ankasa for both shade bearers and NPLD were higher in the major than in the minor rainy season. However with the midday water potential, the shade bearers and NPLD behaved differently. Seasonality pattern of the predawn water potential of all the ecological guilds were similar at Kogyae. It increased from that of early rainy through the major to a maximum value in the minor rainy season. However with the shade bearer, the highest was exhibited in the minor rainy season. The three ecological guilds behaved differently with regard to the midday water potential.

P17-01 – S17 *Palm ecology in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Flower-visitor communities and pollination services to açaí palm (Euterpe oleracea Mart.) in native várzea forest and terra firme plantation – A first perspective

ALISTAIR J. CAMPBELL[1], LUISA G. CARVALHEIRO[2], MARCIA M. MAUES3, MADSON A. B. FREITAS[4], CRISTIANO MENEZES[1]
[1]Embrapa Amazônia Oriental, Botanica, 66095-903, Belem, Brasil
[2]Universidade de Brasília, Departamento de Ecologia, 70910-900, Brasilia, Brasil
[3]Embrapa Amazônia Oriental, Entomologia, 66095-903, Belem, Brasil
[4]Universidade Federal de Pernambuco, Botanica, 50670-901, Recife, Brasil

Background: The açaí palm (Euterpe oleracea Mart.) is native to the flooded forests (várzeas) of the estuarine Amazonian delta region of Brazil, Guyana and Venezuela. The fruit of the açaí palm ('açaí') has long provided a staple food for local riverine communities, and more recently, an important source of income as a result of growing domestic and international demand. Yet, despite the huge ecological, economic and cultural importance of açaí, understanding of its pollination ecology is limited. Furthermore, increased demand for the fruit is driving plantation of açaí in areas of physiologically-unsuitable terra firme habitats, which often require additional inputs (e.g. irrigation, fertiliser) and threaten remaining fragments of dry tropical forest. Our aim was to investigate the reproductive biology of açaí, the identity of important pollinators and the impacts of the transition from native várzea forest to plantation in terra firme on flower-visiting insect communities and pollination services.
Methods: We made observations of flower-visiting insects and compared pollination success in açaí inflorescences under natural conditions (unmanipulated control), bagged (insect-excluded) and hand-pollinated inflorescences to quantify pollination services in 14 areas (7 várzea forest, 7 planted terra firme) close to Belém, Pará, eastern Brazilian Amazon.
Results: Initial results revealed flower-visitor communities were dominated by bees belonging to the Meliponini tribe (Hymenoptera: Apidae), but other bees (Halictidae), ants (Formicidae), wasps (Vespidae), flies (Diptera: Sarcophagidae, Syrphidae) and beetles (Coleoptera: Chrysomelidae, Curculionidae) were also frequent visitors. We viewed a clear distinction in visitor communities of inflorescences in different sexual phases (male or female flowers) and across time periods within days.
Discussion: Results of this project provide growers with practical information on how best to conserve both native pollinator diversity in areas used for açaí production and evidence to support the use of managed pollinators in açaí to improve crop yields.

P17-02 – S17 *Palm ecology in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Population dynamics of the heart of palm tree (Euterpe edulis Mart.,Arecaceae) at the Brazilian Atlantic Rainforest

VALERIA MARTINS1, MAURICIO BONESSO SAMPAIO[1], LUCIANA FERREIRA ALVES[2], VALERIA FORNI MARTINS[3], FLAVIO ANTONIO MAES DOS SANTOS[1]
[1]University of Campinas - UNICAMP, Plant Biology, 13083-970, Campinas, Brazil
[2]Instituto Agronomico de Campinas - IAC, Centro de Pesquisa e Desenvolvimento de Ecofisiologia e Biofisica, 13012-970, Campinas, Brazil
[3]Federal University of Sao Carlos - UFSCar, Natural Sciences, Maths and Education, 13600-970, Araras, Brazil

Background: Studies on population dynamics are useful for planning and monitoring conservation actions as well as for the sustainable exploitation of species. Euterpe edulis Mart. (Arecaceae) is a palm tree considered a keystone species in the Brazilian Atlantic Rainforest due to its massive production of fruit, which is consumed by a large range of frugivores. The species also produces an edible palm heart with high economic value and hence is dramatically exploited in some sites. Short-term demographic studies for some populations of E. edulis have shown contrasting patterns of the annual population growth rate (lambda), which ranged from 1.24 (24% of population growth) to 0.87 (13% of population retraction). The goals of our study were to provide (i) a lambda estimative in a higher spatial and temporal resolution, and (ii) insights into the variation of the population dynamics of E. edulis.
Method: All individuals with diameter at breast height (DBH) >= 4.8 cm were sampled and measured in four permanent 1 ha-plots installed at a protected site of Brazilian Atlantic Rainforest in SE Brazil. Three censuses were conducted along a nine year-period. We categorized all sampled individuals into four DBH classes and constructed three transition matrices from which we calculated lambda. We also calculated the stochastic lambda, which includes temporal variation in population dynamics.
Result: Lambda values ranged from 1.03 to 1.11 among censuses and the population tends to grow 1.6% per year in the long term. The permanency of individuals in the largest size classes contributed the most for lambda.
Discussion: There are reports of sporadic exploitation of E. edulis at the study site, but it seems that the protection of the forest has enabled the persistence of local populations through the survival of large individuals. Variations in lambda along time are likely a result of gap opening effects on recruitment rate. The annual population growth rate calculated by us is comparable to those estimated in small fragments by other authors. However, it is higher than in populations subject to monkey herbivory of the palm heart and lower than in populations previously enriched with seedlings of E. edulis. This indicates that the population dynamics of this species is much more influenced by the disturbance regime than by the size of fragments. When protected and properly managed, small sites may be able to maintain sustainable populations of E. edulis

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P17-03 – S17 *Palm ecology in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Environmental and spatial factors structuring the altitudinal variation of an Atlantic Forest palm assemblage.

SARA L. COLMENARES-T[1], FELIPE C. NETTESHEIM[1], RITA C. Q. PORTELA[1], MARIA I. GUEDES-BRAZ[1], ALEXANDRA S. PIRES[2], EDUARDO A. DE MATTOS[1]
[1]Universidade Federal do Rio de Janeiro, Ecology, 21941-902, Rio de Janeiro, Brazil
[2]Universidade Federal Rural do Rio de Janeiro, Ciências Ambientais, 23897-000, Seropédica, Brazil

Background. Ordination based variation partitioning allows to assess the relative contribution of environmental and spatially structured factors on community assembly. Partitioning procedures offer a set of environmental and spatial fractions that can be associated to niche and neutral processes. Our aim was to determine the contribution of niche and neutral-related factors to explain altitudinal variation trends of an Atlantic Forest palm assemblage composed by 12 taxa differently distributed along a range from 0 to 1400 m.a.s.l. The community richness variation exhibits a hump-shaped curve, where intermediate altitudes are richer. Method. Variation of community composition along elevation was partitioned using distance based Redundancy Analysis. Variation was partitioned into pure habitat [a], pure linear spatial structure [b], pure refined spatial structure [c], and their different shared contributions [d, e, f, g]. Habitat was represented by topography and soil factors, linear spatial structure by geographical coordinates, and refined spatial structure was represented by distance based Moran Eigenvector Maps. Result. The final complete dbRDA model explained 36.25% of total palm assemblage variation ($P<0.05$). Pure habitat [a] explained 18.2%, pure linear spatial structure [b] explained 5.0% and pure refined spatial structure explained [c] 1.5%. Pure environment combined with spatially structured environment [a+d+f+g] explained 27.35%, while pure linear and refined spatial structures combined with the spatially structured space [b+c+e] explained 8.9%. Discussion/Conclusion. The total proportion of explained variation from environmental-related fractions suggests that the altitudinal variation of the palm assemblage is strongly influenced by species–environment relationships associated with local soil conditions and topography, in spite of some variation can be derived from spurious environmental factors. Alternatively, the contribution from the spatial structure to explain community assembly was three times smaller than from the environment and suggests stochastic processes have little influence over the structure of this tropical palm assemblage. In summary, we have evidence that niche processes linked to environmental requirements are having a major role on this community assembly. Works including ontogeny and functional responses at refined spatial scales are needed to continue disentangling the influence of different processes over palms patterns.

P17-04 – S17 *Palm ecology in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Are areas with high environmental suitability really suitable for the initial establishment of species? A case study for an Atlantic Forest endemic palm

GABRIELA AKEMI ODA[1], MARINEZ SIQUEIRA[1], RITA DE CÁSSIA PORTELA[2]
[1]Botanic Garden of Rio de Janeiro, Research Division, 22460-036, Rio de Janeiro, Brazil
[2]Federal University of Rio de Janeiro, Department of Ecology, 21941-902, Rio de Janeiro, Brazil

Spatial patterns of species' distribution may be limited by several biotic and abiotic factors, especially in the early stages of plant development. Species with restricted habits are more vulnerable to extinction, and small climate changes can bring irreversible consequences for the species. This study aims to evaluate the Ecological Niche Model (ENM) in an initial establishment stage for Lytocaryum weddellianum (H.Wendl.) Tol. (Arecaceae), a palm endemic to the Atlantic Forest and restricted to the Serra dos Órgãos region, Rio de Janeiro, Brazil. There were performed (1) Ecological Niche Modeling – ENM and (2) reciprocal sowing experiments between different environmental suitability areas of two populations. The ENM was produced with 16 presence points (> 1km) and nine layers with 30 arc seconds, through the Maxent algorithm. The transplant was performed from the occurrence areas to areas without occurrence record of the species: one with the potential presence (PPA) and another with potential absence (PAA), withal real area of species' presence were used as control. There were assembled a total of 36 experimental stations with 25 seeds in each of these. Abiotic and biotic variables were also raised: soil characteristics, canopy openness, temperature and relative humidity and removal and predation of seeds. The germination rate in the real area of species' presence (<23%) was higher than the PPA (5%) and in the PAA, where no seeds germinated. It was observed high predation rate by invertebrates in PAA (97%) when compared to the PPA (71%) and the control (45%) ($F= 156.55, p< 0.0001$). The environmental conditions in PPA were similar to those in the presence areas of the species, while that PAA had greater canopy openness and different soil conditions. The ENM and field experiments were relevant and complementary, showing different distribution limiting factors for L. weddellianum. Despite the differences in environmental conditions, biotic limitation was important in PAA, however, a limiting predators experiment is suggested for a better comprehension of this relationship. The PPA historical filter seems to be more important, since the L. weddellianum has a slow growth, and probably not reestablished in this area which was extensively degraded in the past. The field experimental validations are important, as well as knowing the historical, physiological and biotic characteristics of the species in order to complement and better interpret the model.

P17-05 – S17 *Palm ecology in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Reproductive success of dioecious Chamaedorea tepejilote in Costa Rica

LUIS DIEGO RIOS, ALFREDO CASCANTE, ERIC J FUCHS
Universidad de Costa Rica, Escuela de Biologia, 11501, San Jose, Costa Rica

Background: Reproductive success (RS) can be limited by resources, pollen quantity or quality. In dioecious species, variation in population sex ratios is common. Whenever males are abundant, a higher variation in their flowering phenology might be expected in order to reduce competition for females. On the contrary, females should invest more in flower production as pollen is not a limiting factor. To test this hypothesis, we analyzed the phenology and female RS of the dioecious palm Chamaedorea tepejilote in a premontane forest in Costa Rica.
Methods: for three seasons (2011-2012, 2013-2014 and 2014-2015) we monitored the phenology of 194 females and 262 males (1.4:1, males to females). All individuals were sexed, mapped, had their height measured and number of leaves counted. Differences in the flowering phenology (flowering onset, amplitude and variance) and reproductive output (number of inflorescences and flowers/inflorescences) between sexes were analyzed with Generalized Linear Models. A Generalized Linear Mixed Effects Model (GLMM) was used to test the effects of flowering time, distance to nearest male, density of males, number of flowers, height, number of leaves and flower number, on the number of fruits/inflorescence and fruit set as proxies of female RS.
Results: The flowering season began in November and peaked between December and January, ending in March. Flowering onset did not significantly differ between sexes. Males produced more and bigger inflorescences and had a significantly higher flowering amplitude and variance than females. Overall mean fruit production was 143.4 ± 4.2 (±SE, min = 6, max = 439). Females with a higher number of flowers matured more fruits. We also noted a weak but significant positive correlation between early flowering females and fruit output. Overall mean fruit set was 46.1 ± 0.8%., and it was also higher in early flowering females.
Discussion: Our results suggest that female RS is not pollen limited, as females that invested in more flowers had higher RS. Male density or proximity to males did not affect RS, which may be explained by the highly skewed male sex ratio. In these scenario, male RS might be higher in those individuals that have high flowering variance as the accessibility to females might be increased.

P20-01 – S20 *Free session: Plant-microbial interactions*
17:30 – 18:30 – Joffre Area (Level 1)

Where are the ectomycorrhizal fungi in the Amazonian lowlands ?

HEIDY SCHIMANN[1], MÉLANIE ROY[2], RICARDO BRAGA-NETO[3], SOPHIE MANZI[2], ELIANE LOUISANNA[1], AUDREY SAGNE[1], VALÉRIE TROISPOUX[1], ROSA ANGELICA ELIAS DA SILVA[4], JAIME DUQUE[4], DAWN FRAME[5], MARIE ALICE NEVES[4]
[1]INRA, ECOFOG, 97329, Kourou, France
[2]Université Paul Sabatier CNRS, EDB, 31062, Toulouse, France
[3]INPA, INPA, 69060-000, Manaus, Brazil
[4]Universidade Federal de Santa Catarina, MICOLAB, 88040-900, Florianopolis, Brazil
[5]IRD, AMAP, 97323, Cayenne, France

Ectomycorrhizal fungi (EMF) are said to be rare in the Amazonian lowlands, outside of the monodominant forests from the Guyana highlands. Indeed, root tip screenings handled on the Amazonian terra-firme soils have revealed only few ectomycorrhizal hosts, associated with pretty low diverse and specific fungal communities. However, based on the numerous fruiting-body collections made by R. Singer in the lower Rio Negro in the late 70's, some habitats like white-sand forests are thought to host many EMF. To draw a first sketch of distribution and diversity of EMF, we gathered inventories of fruiting bodies of putative ectomycorrhizal specimens in Brazil and French Guiana; and specimens deposited in Brazilian herbaria. We targeted 63 genera known as ectomycorrhizal based on literature. We developed a simple and reproductive field experimental procedure to collect and identify fruiting bodies in a large range of habitats across French Guyana and in Brazil. Identification of Fungi was based on morphology and published description; and confirmed by taxonomists. Besides, we collected Brazilian herbaria records of putative EMF genera that might have been sampled in Amazonian lowlands using the speciesLink network (http://splink.cria.org.br), the Brazilian biodiversity database. Our results highlight the wide distribution of EM fungi all over Brazil and French Guiana, not exclusively in white-sand forests. In French Guiana, after a three years survey on 15 sites, more than 406 EM fungal specimens representing 16 families and 34 genera were detected on diverse non-monodominant forests on white-sands, and clay-rich or seasonally flooded soils. In Brazil, our queries resulted in 1006 unique specimens records deposited in 18 herbaria, representing 40 genera and 175 species. Based on herbarium records, we detected 37 EM taxa specifically associated with white sands mostly Cortinarius and Boletaceae, and a few white-spread species found in diverse habitats, such as Cantharellus guyanensis or Russula puiggarii.
In agreement with literature, our results pointed out that EM symbioses remain rare in the Amazon and their species richness is extremely low. However, we showed that EM Fungi persist in hyperdiverse forests, probably in association with few host trees or lianas such as species of Polygonaceae or Nyctaginaceae. Finally, these results raise questions about key drivers of speciation of these taxa in such environments and history of EM families in the Neotropics

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P22-01 – S22 *Earth-mound landscapes: linking spatial organization, ecological processes and raised-field agriculture*
17:30 – 18:30 – Joffre Area (Level 1)

Differentiating pre-Columbian raised fields from natural earth mounds: a new cost-effective remote sensing method

DURÉCU MÉLISSE[2], DELPHINE RENARD[1], MASSOL FRANÇOIS[3], MCKEY DOYLE[2]
[1]University of California, Santa Barbara (UCSB), Bren School, 93106-5131, Santa Barbara, USA
[2]CEFE, CNRS, Ethnobotanique et interactions bioculturelles, 34090, Montpellier, France
[3]EEP / GEPV CNRS Lille 1, Ecologie, évolution, et génomique de l'auto-incompatibilité, F-59655, Lille, France
[4]CEFE, CNRS, Ethnobotanique et interactions bioculturelles, 34090, Montpellier, France

Background. The nature and scale of pre-Columbian human modifications of Amazonian landscapes are still debated after 40 years of research. This is partly because vestiges of human activities can resemble features of natural origin. Vestiges of some types of pre-Columbian agricultural raised fields and earth mounds built by soil engineers (e.g., social insects, earthworms) in wetlands offer a striking illustration of such resemblance. Intensive fieldwork, to uncover various proxies for environment and human activities, is required for convincing evidence on the origin of earth mounds. We have developed a method using remote sensing to compare the spatial structure of agricultural raised fields with that of natural earth-mound landscapes. We use this method to test the hypothesis that the mound patterning emerging from natural processes is different from that imposed by farmers. The differences can be used to characterize the natural or anthropogenic nature of landscapes prior to initiating fieldwork.
Method. We quantified the periodicity (regularity in distance between mounds), intensity (proportion of the total variation explained) and orientations of mound spatial pattern using spectral analysis applied to digitized aerial and satellite images. We conducted the analysis on 100 windows, each 40 m x 40 m, for each of four landscapes: (1) present-day raised fields in Africa (Zambia), (2) earth-mound landscapes of natural origin in the same sites, (3) vestiges of pre-Columbian raised fields in French Guiana and (4) earth-mound landscapes (surales) made by earthworms in Colombia.
Results. We showed that natural and cultural earth-mound landscapes are both characterized by intense and highly periodic patterns, but only patterns created by present-day and ancient farmers showed strong orientation, often in square lattices (alignment of mounds in two directions separated by 90°). Honeycomb hexagonal structures, predicted to emerge in termite-mound landscapes by some models, were not observed in our analysis.
Discussion/conclusion. Our method can be used to differentiate cultural and natural features based on the orientation of landscape patterns, providing a cost-effective way for archaeologists to target field sites of interest and contributing to elucidating the extent of pre-Columbian ecological impact in peri-Amazonian seasonal wetlands. These findings advance our understanding of the ecological and cultural processes that shape present-day landscapes.

P23-01 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Tropical birds can smell trees calling for help along an elevational gradient: An experiment with chemically and manually induced herbivory

HUMLOVA ANNA[1], SAM KATERINA[2], KOANE BONNY[3]
[1]University of South Bohemia, Faculty of Science, 37005, Ceske Budejovice, Czech Republic
[2]Biology Centre CAS, Institute of Entomology, 37005, Ceske Budejovice, Czech Republic
[3]The New Guinea Binatang Research Centre, Entomology, 602, Madang, Papua New Guinea

Smell and olfactory in birds are extensively studied from the second half of the 20th century. Only recently, experiments showed that birds are using olfactory more than we ever expected. It was for example confirmed that insectivorous birds can smell volatile compounds which are released by leaves damaged by herbivorous insect. Recent studies were however conducted only on a simple study system "Great Tit – Birch – Autumnal Moth". Our aim was to investigate the ability of tropical insectivorous birds to use herbivore-induced plant volatiles (HIPV) to aid search for prey. We conducted the research at several sites in lowlands and along elevational gradient of Mt. Wilhelm in Papua New Guinea. In first experiment, we induced HIPV mechanically on several plant species along elevational gradient. In second experiment, we induced HIPV by Jasmonic Acid on Ficus phaeosyce in lowlands, and Ficus hahliana. Attractivity of treated (mechanically or chemically) and untreated/control saplings to predators of herbivorous insect was studied with aid of plasticine caterpillars. Exposition of green plasticine caterpillars allowed us to compare predation attacks by individual groups of predators on various saplings and at different elevations. Along elevational gradient, the predation rate decreased with altitude from 10% day-1 at 200m asl to 1.8% day-1 at 3700m asl. Ants were relatively more important predators in the lowlands, while birds became dominant predators above 1700m asl. Caterpillars exposed on trees with herbivorous damage were attacked significantly more than caterpillars exposed on trees without damage. The herbivory attracted both ants and birds, but its effect was stronger for ants. Similarly, caterpillars exposed on saplings treated with jasmonic acid attracted significantly more predators, and this response lasted for about 48 hours. In lowlands, saplings treated with jasmonic acid were more attractive to all predators than saplings with mechanically damaged leaves. The attractivity of individual plant species differed significantly both for control and experimental treatments. The predation pressure from various predators correlated closely with abundance of potential predators but not with their species richness. The project was financially supported by GACR 14-32024P.

P23-02 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Identifying the chemistry and quality of ant-mediated seed dispersal of Neotropical pioneer tree species by the common, ground dwelling ant, Ectatomma ruidum

SELINA RUZI[1], ANDREW SUAREZ[2]
[1]University of Illinois at Champaign-Urbana, School of Integrative Biology, 61801, Urbana, USA
[2]University of Illinois at Champaign-Urbana, Animal Biology, 61801, Urbana, USA

Ant-mediated seed dispersal has evolved repeatedly in many regions around the world. Most research on ant-mediated seed dispersal focuses on plants with elaiosomes (food bodies) attached to their seeds. However, seeds without elaiosomes can also be attractive to ants despite not providing a reward. Ants do not often disperse seeds long distances, however, they can cache them in favorable microsites below ground until the right conditions for germination occur. This process may be particularly important for Neotropical pioneer tree species as they require light gaps that are unpredictable in time and space to germinate and establish. The goals of our research are to: 1) Identify the chemical cues that play a role in seed dispersal in Neotropical pioneer tree species, and 2) measure seedling emergence for seeds cached by ants. We field-tested hexane and methanol seed extracts from six Neotropical pioneer tree species. All six species lack an elaiosome food reward, but three elicited a seed carrying response. Seeds and hexane extracts of one species in particular, Zanthoxylum ekmanii, were consistently removed by the ant Ectatomma ruidum. Hexane extracts of Z. ekmanii were further fractioned via column chromatography to separate hydrocarbons from polar compounds. Fractions were then presented in laboratory behavioral assays to narrow down the chemical cue(s) that elicit seed carrying. In field tests, E. ruidum attempted to remove both seeds and hexane extracts of Z. ekmanii at similar rates (33.6% and 37.4% of the time periods respectively) while ignoring other experimental and control extracts. In laboratory assays, E. ruidum colonies often exhibited variation in response with some acting indifferently to all stimuli while others consistently moved filter paper with Z. ekmanii hexane extracts or polar compounds into the colony chamber. To understand the quality of seed dispersal experienced by Z. ekmanii we provisioned E. ruidum colonies with seeds prior to wax casting the nests to determine caching depth. We paired this with a seedling emergence study to determine if seeds were cached at a depth appropriate for seedling emergence. Our results provide a better understanding of both the mechanism behind ant-mediated seed dispersal when no food reward is provided, and how ants influence seed fate post dispersal.

P23-03 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Modulation of the defense chemistry of Ficus insipida at sub-phytotoxic concentrations of ozone

GERALD SCHNEIDER[1], ALEXANDER CHEESMAN[2], THOMAS KURSAR1, BENJAMIN TURNER[3], KLAUS WINTER[3]
[1]University of Utah, Biology, 84112, Salt Lake City, USA
[2]James Cook University, Centre for Tropical Environmental and Sustainability Studies, 4870, Cairns, Australia
[3]Smithsonian Institution, Smithsonian Tropical Research Institute, 0843-03092, Balboa, Ancon, Republic of Panama

Background: Tropospheric ozone pollution is a globally increasing problem, affecting carbon dynamics, ecological interactions, and agricultural productivity across continents and biomes. Through its effects on plant physiology and biochemistry, ozone pollution can alter plant defense chemistry and, in turn, influence plant-consumer interactions. Previous studies have indicated hotspots of ozone or ozone precursor pollutants in several tropical forest airsheds. However, the effects of ozone on vegetation have been relatively understudied in tropical regions, where plant defense chemistry and plant-consumer interaction rates are the highest of any terrestrial biome.
Methods: In this study, we investigated the effects of ambient ozone levels on seedlings of Ficus insipida (Moraceae), a regionally abundant Neotropical tree. The study was located in central Panama, in an airshed shared by forests and a large urban/commercial zone. We grew the F. insipida seedlings for two months in open-top chambers supplied with filtered or ambient air. We harvested the two most distal leaves from each seedling and compared leaf chemistry between treatments and across leaf ages. The leaf chemistry analyzed included secondary metabolites and membrane lipids. Metabolite analyses were conducted using UPLC-MS and MS-MS.
Results: Depending on leaf age, the secondary metabolite suite exhibited downregulation or a combination of up- and downregulation in ambient air. Membrane lipids were present at lower concentrations in older leaves grown in ambient air, indicative of accelerated senescence.
Discussion: Although this airshed proved not to be a hotspot of ozone pollution, with mean ozone mixing ratios below the levels known to induce chronic ozone stress in broadleaved plants of the temperate zone, leaf chemistry differed significantly between treatments. Our results indicate that ozone can affect plant defense chemistry at concentrations comparable to the global mean, well below the documented thresholds for growth inhibition or visible leaf damage.

P23-04 – S23 *Chemical ecology: new insight in comprehending biotic interactions in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

De novo transcriptome sequencing in Valasia javana Mayr (Agaonidae) to identify genes involved in olfactory system

YU HUI
Chinese Academy of Sciences, South China Botanical Garden, Xingke Road 723, Tianhe district, 510650, Guangzhou, China

The system of figs and their pollinating fig wasps is widely regarded as a model for coevolved mutualism. The high degree of host specificity is presented by a phenomenon that the female pollinators are only attracted by its specific fig tree species through the volatile organic compounds (VOC) released by the figs when they are ready to be pollinated. However, very little is known about the molecular mechanism underlying how the females are attracted by the VOC and how they achieve pollinator species-specificity. Here we present transcriptome sequencing data from VOC-treated wasps and control samples. Using Illumina paired-end sequencing, approximately 6.48 Gbp and 6.47 Gbp high quality reads were generated for the control and VOC-treated wasps, respectively. After read trimming, the de novo assembly of both types of reads produced 58, 192 unigenes were finally generated with an average length of 817 bp. Then functional annotation and GO enrichment analysis was performed by aligning all-unigenes with public protein databases including NR, SwissProt, and KEGG. Differentially expressed genes (DEGs) were investigated using the RPKM method. Overall, 16 up-regulated genes and 13 down-regulated genes were identified. To increase our understanding of these DEGs, we performed GO enrichment and metabolic pathway enrichment analyses. Based on these results, 1 gene involved in synaptic vesicle cycle and 2 genes of odorant binding protein OBP were selected and discussed. This is the first transcriptome sequencing of this non-model species under VOC using Illumina/Solexa, a next-generation sequencing technology. We hope that our findings further shed light on the Fig-fig wasp interactions and provide better understanding for the coevolved mutualism.

P24-01 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Antagonistic or mutualistic? Ant-diaspore interactions in a Nigerian montane forest.

JENNIFER AGALDO[1], HAZEL CHAPMAN[1], ALEXANDER CHRISTIANINI[2]
[1]University of Canterbury, Christchurch. Newzealand., School of Biological Science, 8041, Christchurch, Newzealand
[2]Universidade Estadual de Campinas, Programa de Pos-Graduacao em Ecologia, Departamento de Biologia de Aminal, 13083-970, Campinas, Brazil

Ants are important dispersers of myrmecochores (plants whose seeds have appendages attractive to ants) and recently their role as dispersers of small seeds from fleshy fruits more obviously adapted for vertebrate dispersal has been established. This suggests that ants may promote seedling establishment in ecosystems lacking myrmecochores. In the study area, Ngel Nyaki (NN) forest in the mountains of East Nigeria, no myrmecochores have been observed, yet ants comprise a significant proportion of the invertebrate biomass. Preliminary observations indicate frequent ant-diaspore interactions. Here we explore the nature of these interactions to determine if they are antagonistic or mutualistic. This is important as nothing is known about ant-diaspore interactions in West African montane forests. These forests are losing their primary dispersers and ants could act as substitutes for some small seeded species.
This study, undertaken during the wet season when ants are most common, included both opportunistic observations and diaspore removal experiments. In the removal experiments a total of 78 stations, each comprising four diaspores of one of seven plant species were used in three different site locations, each of the 78 stations was observed for 15 minutes.
Results from both methods found that only two ants (Formicidae: Myrmicinae), out of about 10 species found in the site, interacting with diaspores. From opportunistic observations, the ants interacted with the diaspores of five woody species (Psorospermun aurantiacum, Paullinea pinnata, Syzigium macrocarpa, Chionanthus africanus, Zanthoxylum sp.) by cleaning seeds, and moving diaspores. Results from the removal experiments showed diaspores of two species, both from the Cannabaceae family, were moved away from the stations; approximately 2% of Celtis gomphophylla (a tall forest tree) and 19% Trema orientalis (a pioneer tree). Average removal distance was 28 cm, (range 20-120 cm from 142 observations). Forty eight percent of diaspores taken were deposited into ant nests and so far, five seedlings of T. orientalis have germinated within three ant nest locations.
Ants can aid seed germination and seedling establishment of some plant species in NN through seed cleaning, burial and moving of diaspores. Future work involves following the fate of the seeds moved into ant nests and comparing seed fate between nest and non-nest sites as well as comparing germination rates of ant cleaned and non cleaned seeds.

P24-02 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

Functional leaf anatomy of neotropical orchids with contrasting photosynthetic pathways

JUSTINE ROJAS, KATIA SILVERA, NORMAN ELLSTRAND
University of California Riverside, Botany and Plant Sciences, 92521, Riverside, United States

Crassulacean Acid Metabolism (CAM) is a water-conserving mode of photosynthesis present in about 7% of vascular plant species. CAM is particularly widespread in the largest family of flowering plants, the Orchidaceae. In neotropical regions, orchids are endangered and considered bioindicators of forest health. Epiphytic tropical orchids can be flexible in their responses to environmental changes and utilize different photosynthetic pathways, ranging from C3 photosynthesis (the typical form of photosynthesis) to facultative or intermediate forms and strong CAM. To investigate patterns of functional diversification related to the expression of CAM in orchids, we compared the anatomical patterns of orchids species with C3, weak CAM and strong CAM using cross section and leaf surface images of neotropical orchid species with contrasting photosynthetic patterns. Carbon isotopic composition of leaf material showed a typical bimodal distribution with most species exhibiting values near –27, suggesting a C3 pathway, or around –12, suggesting a CAM pathway. Leaf succulence is consistently related to the expression of CAM, and related to increase mesophyll cell size and low intercellullar air space. Thicker leaves often signified a predominantly CAM pathway, whereas thinner leaves were related to C3 photosynthesis. Even though thick leaves were related to carbon isotopic composition values in the CAM range, some thin-leaved orchids were capable of CAM photosynthesis when titratable acidity measurements were performed. Stomatal density between species were also compared and related to photosynthesis type. The trajectory of anatomical progressions from C3 to weak CAM to strong CAM, and the evolution of CAM in terms of anatomical constraints is further discussed. This analysis is part of a larger project in which orchid species will be analyzed from living and preserved specimens for a greater understanding of the evolution of photosynthetic pathways in plants.

P24-03 – S24 *The future of tropical montane forests: biodiversity, climate change, land use, and conservation*
17:30 – 18:30 – Joffre Area (Level 1)

The effect of density, herbivory and competition with a native bamboo on seedling recruitment of the endemic Costa Rican oak Quercus costaricensis

IRENE CALDERÓN-SANOU, LUIS DIEGO RÍOS, ERIC J. FUCHS
Universidad de Costa Rica, Escuela de Biología, --, San Jose, Costa Rica

Background: Negative density dependence has been long posited as a possible mechanism explaining species coexistence in tropical forests. Quercus costaricensis is a dominant oak species in Costa Rican mountains. Adult trees reproduce in synchronous masting events, leading to the germination of large numbers of seedlings. Exploring the relative importance of density-dependence on seedling mortality and recruitment may provide insights into the mechanisms regulating population dynamics of an endemic and abundant species in montane forests.
Method: All Q. costaricensis individuals were tagged and measured in four 20x20m plots that differed in amount of native bamboo Chusquea spp. We used spatial statistics and generalized linear mixed models to determine the effects of conspecific density, the density of Chusquea spp. and the amount of herbivory on the survival probability of 2029 seedlings.
Result: Seedlings were always spatially aggregated among themselves and with adults. Seedling height had a positive effect on survival, while Chusquea spp. abundance and herbivory affected it negatively. Negative density dependence was only observed at intermediate and high densities of Chusquea spp.
Discussion: Masting and gravity dispersion results in dense seedlings clumps, which should be subject to density dependent regulation. Despite large levels of herbivory, predator satiation may explain the lack of density dependent regulation in this species. Density-dependent mortality is observed at different densities of Chusquea spp., suggesting a complex oak-bamboo interaction.
Conclusion: Quercus costaricensis high population densities attract natural enemies that influence seedlings survival, independent of local conspecific densities. Herbivory and native bamboo Chusquea spp. may be the main biotic factors regulating seedlings recruitment in this endemic oak population.

P26-01 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
17:30 – 18:30 – Joffre Area (Level 1)

Terrestrial mammal responses to riparian forest connectivity in an Amazonian hyper-fragmented landscape

BARBARA ZIMBRES[1], CARLOS PERES[2], RICARDO MACHADO[1]
[1]Universidade de Brasilia, Departamento de Zoologia, 70910-900, Brasilia, Brazil
[2]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

Background: Extensive 1970-2010 deforestation in the Brazilian Amazon has generated a ~100Mha fragmented region known as the 'arc of deforestation'. Brazilian farmers and cattle ranchers are legally required to set-aside riparian forest strips, but recent legislative changes have relaxed the requirements of riparian forests to be retained within private landholdings. Here, we assess the role of linear riparian forest remnants as landscape connectors for medium to large-bodied terrestrial mammals in a vast fragmented landscape, thereby guiding future management decisions and contributing to policy discussions about the impacts of these changes.
Method: In a highly fragmented region of Southern Amazonia, we selected 39 riparian forest strips and five riparian pseudo-control continuous forests. We installed four to five camera traps along each riparian zone (199 trap stations), and sampled the terrestrial mammal community for 30 days per year during the dry seasons of 2013 and 2014. We compared riparian forest use by mammals, both within continuous and highly fragmented forests, and tested the effects of corridor quality, structure and landscape context on community richness, composition, and functional diversity.
Result: Richness and functional diversity were significantly higher in continuous forests than in riparian remnants. Forest habitat degradation was associated with overall lower species richness, whereas the richness of forest-specialists alone was positively affected by corridor width. Functional diversity responses reflected those of species richness, but no differences were detected when accounting for the effect of richness on the functional diversity metric. Compositional shifts indicate that deforestation and forest degradation will select for matrix-tolerant species with lower levels of forest habitat specificity.
Discussion: Our study highlighted the potential of riparian corridors in maintaining landscape connectivity for terrestrial medium to large-sized mammals, and revealing that corridor width and forest degradation status are the most important predictors of community-wide response metrics. Narrow and/or degraded corridors will sustain fewer species, and ecosystem functions will ultimately succumb to disruptions mediated by species losses.

P26-02 – S26 *Ecological impacts of forest disturbance in the brazilian amazon*
17:30 – 18:30 – Joffre Area (Level 1)

Effects of forest height and vertical complexity on bat abundances and biodiversity in a highly fragmented Amazonian landscape

ANA C. M. MARTINS, MICHAEL R. WILLIG, STEVEN J. PRESLEY, JADER MARINHO-FILHO
[1]University of Brasilia, Graduate Program in Ecology, 70910-900, Brasilia, Brazil
[2]University of Connecticut, Center for Environmental Sciences & Engineering and Department of Ecology & Evolutionary Biology, 06269, Storrs, USA
[3]University of Connecticut, Center for Environmental Sciences & Engineering and Department of Ecology & Evolutionary Biology, 06269, Storrs, USA
[4]University of Brasilia, Department of Zoology, 70910-900, Brasilia, Brazil

Anthropogenic activities have accelerated habitat change, loss, and fragmentation, threatening biodiversity over large portions of the tropics. Because seed dispersers, pollinators, or top predators, such as bats, contribute to the structure and function of forests, they deserve particular attention as they directly affect forest integrity. Thus, understanding how the abundances and biodiversity of bats are affected by variation in vegetation structure in fragmented forests is needed to inform management and conservation action. To do so, bats were collected at 24 sites in the southern Brazilian Amazon (96 nights, 8640 m2.h / site), and vegetation structure (density, height and basal area of trees, density of understory and canopy openness) was quantified as well. Using generalized linear models, we tested simple relationships of each structural characteristic with community- (taxonomic and phylogenetic dimensions of biodiversity) and population-level attributes of bats. The models for total abundance, taxonomic biodiversity (species diversity and dominance) and phylogenetic diversity were significant, increasing with increasing tree height and basal area, and decreasing with increasing canopy openness. At the population level, abundances of frugivores (Carollia perspicillata, Rhinophylla pumilio, Artibeus planirostris, A. obscurus, A. lituratus, Uroderma bilobatum) and nectarivores (Lonchopylla thomasi, Glossophaga soricina) were related significantly to vegetation structure. Some understory frugivores exhibited negative relationships with tree height, choosing younger forests, whereas canopy frugivores chose closed canopy forests. Of the nectarivores, L. thomasi was more abundant in older forests (negative relationship with density of trees), whereas G. soricina was more abundant in areas with low canopies and low basal area (i.e., earlier successional forest). Consequently, government agencies should continue to prioritize forest connectivity and patch size when evaluating forested sites for conservation action, but should include consideration of local forest age and structure as well. In general, protecting areas with large trees and closed canopies enhances the persistence of pollinators and seed dispersers.

P27-01 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
17:30 – 18:30 – Joffre Area (Level 1)

Plant phenology and fruit-frugivore interactions in Amazonian seasonally flooded and unflooded forests

JOSEPH E. HAWES
University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

Understanding plant productivity, and its effects on animal communities, is vital for predicting the resilience of tropical forests. Progress is now being made in compiling long-term data to analyse phenology patterns on an unprecedented spatial scale. However, many gaps in our coverage remain, with vast areas of tropical forests unsurveyed. Few studies have monitored community-wide patterns in seasonally flooded Amazonian forests, where the annual flood pulse generates perhaps the most seasonal low-latitude ecosystem on Earth.
We monitored vegetative and reproductive plant phenology in várzea (VZ) floodplain and adjacent terra firme (TF) forests along the Juruá River in western Brazilian Amazonia, using three complementary methods: monthly canopy observations of 1056 individuals, twice monthly collections from 0.5-m^2 litterfall traps within two 100-ha plots (96 traps per plot), and monthly ground surveys of residual fruit-fall along 12-km transect-grids within each 100-ha plot. Phenological surveys were coupled with monthly transect surveys of medium- to large-bodied vertebrate frugivores, and interviews with experienced hunters and fishermen from local communities, to construct fruit-frugivore networks.
Phenology patterns were generally similar in both forest types. Leaffall peaked during the aquatic phase in VZ forest and the dry season in TF. Flowering typically followed leaffall and leaf flush, extending into the onset of the terrestrial phase and rainy season in VZ and TF, respectively. Abiotic seed dispersal modes were relatively more prevalent in VZ than TF, where plants are more heavily dependent upon animal seed dispersal agents. The annual flood pulse in VZ forests had an overriding influence on the turnover of both fruit resources (152 plant genera) and frugivores (36 functional groups) between the two forest types, with higher-order effects on network structure. We highlight that plant phenology, fruit productivity and fruit-frugivore interactions remain vastly understudied in flooded forests. An understanding of phenological patterns is vital to differentiate between missing and forbidden links in networks, particularly in seasonally flooded forests where the terrestrial frugivore community is completely replaced by aquatic species for half the year. We emphasize the difficulty in confirming the flood pulse as a phenological trigger without multiannual data or spatially replicated studies across the spectrum of Amazonian forest types.

P27-02 – S27 *Long-term trends of tropical plant phenology: consequences for plants and consumers*
17:30 – 18:30 – Joffre Area (Level 1)

Reproductive size thresholds of timber species in central Africa: variation among forests and implication for forest management

DAKIS-YAOBA OUÉDRAOGO[1], ADELINE FAYOLLE[1], FIDÈLE BAYA[2], ACHILLE BIWOLÉ[1], NILS BOURLAND[1], KASSO DAÏNOU[3], FOUSSENI FETEKE[1], EMILE FONTY[1], JEAN-FRANÇOIS GILLET[1], YAO LAMBERT KOUADIO[1], JEAN-LOUIS DOUCET[1]
[1]University of Liège -- Gembloux Agro-Bio Tech, BIOSE -- Management of Forest Resources -- Tropical Forestry, 5030, Gembloux, Belgique
[2]Ministère des Eaux, Forêts, Chasse et Pêche, Forêts, BP 3314, Bangui, République Centrafricaine
[3]Nature+, Sylviculture, 1301, Wavre, Belgique

Background: The onset, duration, and timing of the reproductive activity of trees are important variables for evaluating the functioning of tropical forests. The diameter at which a tree reproduces is also a key component because it has direct implications for forest management. The definition of minimum diameter cutting limits should ensure that enough "seed trees" are left for post-logging regeneration. In this study we assessed within- and between-species variation in the reproductive size of 16 central African timber species. We specifically questioned the suitability of legal minimum cutting diameters limits (MCDL) for a sustainable management of production forests.
Method: We analyzed monthly phenological field surveys conducted over up to five years at six sites, from evergreen forests (Cameroon) to semi-deciduous forests (Cameroon, Congo, and Central African Republic). First we estimated the reproductive diameter thresholds of the species at each site using logistic regressions, and tested for differences between species. Then we examined whether differences in reproductive diameter between the individuals of the same species could be explained by competition for light and/or by a site effect. Finally, we compared our results with the MCDL.
Results: We evidenced significant differences between species reproductive diameter thresholds, and a strong effect of light on these thresholds. We also evidenced significant differences between sites that need further investigations. Finally, we found for several species reproductive diameter thresholds higher than MCDL.
Conclusion: This result underlines the need for harmonization of MCDL in the Congo basin. Such harmonization should be based on sound ecological data.

P28-01 – S28 *Primates on the move: from local to landscape scale*
17:30 – 18:30 – Joffre Area (Level 1)

Plant-animal interactions integrated into dynamic vegetation models: climate change impacts on the distribution of tree species used by Leontopithecus chrysomelas, and the monkeys' role in forest regeneration

RAGHUNATHAN NIMA
RAGHUNATHAN NIMA[1], FRANÇOIS LOUIS[2], CAZETTA ELIANA[3], DEVLEESCHOUWER KRISTEL[4], HUYNEN MARIE-CLAUDE[1], HAMBUCKERS ALAIN[1]
[1]University of Liege, Behavioural Biology, 4020, Liege, Belgium
[2]University of Liege, Climate Modelling and Bio-geochemical cycles, 4000, Liege, Belgium
[3]Universidade Estadual de Santa Cruz, Ecology and Conservation of Biodiversity, 45662-900, Ilhéus, Brazil
[4]Royal Zoological Society of Antwerp, Centre for Research and Conservation, 2018, Antwerp, Belgium

Climate change is among the major threats to natural ecosystems around the world. In the tropics, where more than 90% of the vegetation relies on frugivores for their dispersal, the ability of a given plant species to adapt and migrate towards climatically adequate conditions depends largely on seed dispersal by frugivores. In the northern range of the Brazilian Atlantic Forest (BAF), the endangered Leontopithecus chrysomelas (golden-headed lion tamarins; GHLTs) plays an important role in seed dispersal. In this research, we aim to integrate a seed-dispersal module, built from field data studying the feeding ecology and dispersal patterns of GHLTs for a focal tree genus (Pourouma species) into a dynamic vegetation model (CARbon Assimilation in the Biosphere CARAIB-DVM). The model would be further used to understand the potential impacts of climate change on the distribution of the tree species, and to evaluate the role of the monkeys in forest regeneration. Simulations of climate change impacts in future scenarios without dispersal limitation shows that tree species used by GHLTs may not suffer duly from range-loss, if soil water levels are maintained. The dispersal module's inclusion into the larger model may reduce the migration rate of tree species, and therefore pose an additional risk under future climate conditions. Trees with larger seed sizes will also be at higher risk in areas where larger-bodied frugivores are locally extinct in terms of dispersal and migrating to favourable conditions.

P28-02 – S28 *Primates on the move: from local to landscape scale*
17:30 – 18:30 – Joffre Area (Level 1)

Integrating ground samples and remote sensing data to derive influential and spatially explicit predictors of arboreal primate abundance

NATHALIE CAVADA[1], MARCO CIOLLI[1], FRANCESCO ROVERO[2]
[1]University of Trento, DICAM, 38123, Trento, Italy
[2]MUSE - Museo delle Scienze, Trento, Tropical biodiversity section, 38122, Trento, Italy

Accurate density and abundance estimation are required for the management of threatened animal species. This is particularly critical for primates, that are mostly found in altered and fragmented landscapes within tropical rainforests. In this study we applied a hierarchical modeling approach and incorporated the effect of environmental covariates on both the detection (i.e. observation) and the state (i.e. abundance) processes of distance sampling. We focused on three arboreal primates that are found in the Udzungwa Mountains of Tanzania and applied the method to published data. We found that accounting for covariates makes the inference process more informative, when compared to previous 'canonical' estimation, as this takes in full account the contrasting habitat and protection level of the different forest blocks in the study area. Density estimates were corrected for imperfect detection, an approach that appeared especially critical where species detectability was low, as in unprotected forests. Moreover, the inference on density is spatially-explicit to the scale of the covariates used in the modelling; hence, when these are available across the study sites inference on density can be made beyond the field sampled points. Nevertheless, the availability of spatially diffuse environmental predictors of abundance, may be challenging, especially in complex habitats. To overcome such issue we developed an approach that calibrates Landsat images to ground-taken measurements of arboreal vegetation. We derived a parameter of forest structure, basal area, which is a common predictor of primate abundance, including the endemic and endangered Udzungwa red colobus in our study. Hence, we estimated density for such species using the modelled values of basal area and compared estimates against those from hierarchical distance sampling fed with ground measurements of basal area. We found our approach to be able to accurate predict the primate density across the entire study area, as this was consistent with results obtained in previous studies, but with limited spatial coverage. This approach is of high potential for the assessment and conservation of threatened species that are found in complex and heterogeneous landscapes, such as most tropical rainforests, as it provides critical information for sites prioritization.

P29-01 – S29 *Impacts of drought on tropical forests: processes and tipping points*
17:30 – 18:30 – Joffre Area (Level 1)

The relative effect of water versus light availability on seedling mortality in Panama

STEFAN J. KUPERS[1,2], NADJA RÜGER[1,2,3], BETTINA M.J. ENGELBRECHT[3,4], CHRISTIAN WIRTH[1,2], S. JOSEPH WRIGHT[3]
[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany
[2]Institute of Biology, Leipzig University, Johannisallee 21, 04103 Leipzig, Germany
[3]Smithsonian Tropical Research Institute, Apartado 0843-03092, Balboa Ancón, Panama
[4]University of Bayreuth, Universitätsstrasse 30, 95440 Bayreuth, Germany

Light is regarded to be the main abiotic niche for shaping tree communities in moist tropical forests. However, there are manifold signs that droughts can strongly affect tree communities in the tropics, particularly by elevating mortality rates. Barro Colorado Island (BCI) in Panama island experiences pronounced dry seasons and is vulnerable to El Niño droughts. Whereas the light niche has been quantified, the role of soil moisture remains unknown for the majority of the tree species in the forest. We measured soil water availability in two consecutive dry seasons, at 200 seedling plot locations that have been inventoried annually for more than 20 years. We modeled the spatial distribution of soil moisture throughout the 50-ha plot and reconstructed water availability through time. We found pronounced spatial and temporal differences in the water availability in the plot throughout the dry season. This formed the basis for the quantification of the effect of water availability on seedling mortality rates for many of the 200+ species, and allowed us to compare the effect of water versus light availability. Preliminary results show that light availability is a more important driver for seedling mortality rates than water availability. Further analyses are underway to verify this and to ultimately disentangle the relative importance of these niches for seedling demography and the potential of resource partitioning for explaining the high diversity of tropical forests. Our results will allow for improved predictions of the effect of climate change and possible changes in the frequency and intensity of droughts on tropical forest composition and dynamics.

P29-02 – S29 *Impacts of drought on tropical forests: processes and tipping points*
17:30 – 18:30 – Joffre Area (Level 1)

Large-scale Neotropical genera distributions predict drought-induced mortality of trees

ESQUIVEL MUELBERT ADRIANE[1], BAKER TIMOTHY[1], DEXTER KYLE[2], LEWIS SIMON[1], GALBRAITH DAVID[1], TER STEEGE HANS[3], MEIR PATRICK[4], ROWLAND LUCY[2], LOPEZ-GONZALEZ GABRIELA[1], PHILLIPS OLIVER[1]
[1]University of Leeds, School of Geography, LS2 9JT, Leeds, United Kindom
[2]The University of Edinburgh, School of Geosciences, EH9 3FE, Edinburgh, United Kindom
[3]Naturalis Biodiversity Center, Biodiversity Dynamics from species to systems, 2333, Leiden, The Netherlands
[4]Australian National University, School of Biology, ACT 2601, Acton, Australia

Background: Droughts are an increasing threat for tropical rain forests, with impacts to forest biodiversity and ecosystem services, including carbon storage. Within the tropics tree species richness is positively associated with precipitation, which is likely to be a consequence of water-stress constraining important physiological processes of most taxa. If so, macroecological distributions of tropical taxa would provide valuable insights about the potential impacts of droughts on Neotropical diversity.
Methods: We combine data from 531 inventory plots of closed canopy forest across the Western Neotropics to investigate how water-deficit influences the distribution of tropical tree genera. For that, we firstly calculated genera Ôwater deficit affiliationÕ (WDA), which represents the mean of taxa distributions along the water-deficit gradient weighted by their abundance. Secondly, we tested the ability of WDA to predict drought-induced mortality at one natural and four experimental droughts across the Neotropics.
Results: Drought tolerant genera tend to be disproportionally widespread across the precipitation gradient, reaching even the wettest climates sampled. However, most genera are restricted to wet areas. Macroecological distributions did predict drought resistance, with wet-affiliated genera tending to show higher drought-induced mortality regardless of their life history stage and after accounting for the influence of phylogeny.
Discussion: The large-scale distributional patterns of genera with respect to climate have predictive value for their vulnerability to water-stress. It is the first time this question has been assessed at a macroecological scale for the tropics. Our results suggests that the anticipated increase in extreme dry events for this region may threaten biodiversity, given that the majority of Neotropical taxa are wet-affiliated and that most of these have relatively small ranges. Overall, this study establishes a baseline for exploring how floristic composition of tropical forests may shift in response to current and future environmental changes in this region.

P30-01 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
17:30 – 18:30 – Joffre Area (Level 1)

Call for soil: the need to include soil data in restoration projects

AGNIESZKA LATAWIE, BERNARDO STRASSBURG, LUISA LEMGRUBER, HELENA ALVES NERY
International Institute for Sustainability, IIS, 22450130, Rio de Janeiro, Brazil

Although several restoration programs are being developed in Brazilian Atlantic Forest, a heavily deforested biome (only around 10% of the original cover is left) and biodiversity hotspot, it is still a challenge to evaluate the effectiveness of these programs from the socioeconomic point of view. Because socioeconomic factors may have significant influence on restoration success, while restoration project may heavily impact local population, it is therefore essential to consider these factors in restoration. This study aims to evaluate the restoration program Mutirão de Reflorestamento, implemented in the municipality of Rio de Janeiro, through socioeconomic indicators. The project was developed in the 80's by the Secretary of Environment of Rio de Janeiro municipality, and is currently active in 150 areas, having restored three thousand hectares and involved 800 workers from nearby communities. In order to evaluate the effects of Mutirão de Reflorestamento, we chose seven communities and we applied the following socioeconomic indicators: community perception about the Project Mutirão de Reflorestamento; community level of involvement in each stage of the project (planning, implantation, maintenance and monitoring); changes in income and wellbeing due to the program implementation; community perception on the provision of environmental services; increased qualified workforce due to the new obtained skills; community contribution for project improvement; and dialog between community and government. We found that, in general, there was an increase in community's perception about the importance of the forest for the provision of ecosystem services. For instance, we observed the perception of direct association of forest regeneration, landslides reduction and water and air quality improvement. Further, the sense of responsibility for the environment has increased. On the other hand, some communities pointed to negative effects such as the increase of mosquitoes and snakes and security issues. The results of this project are being disseminated to other communities for capacity building and higher acceptance of environmental initiatives at municipality level.

P30-02 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
17:30 – 18:30 – Joffre Area (Level 1)

Ecological responses to experimental glacier-runoff reduction in tropical mountain streams

SOPHIE CAUVY-FRAUNÉ[1], PATRICIO ANDINO[2], RODRIGO ESPINOSA[2], ROGER CALVEZ[3], DEAN JACOBSEN[4], OLIVIER DANGLES[5]
[1]IRSTEA, DYNAM, 69626, Villeurbanne, France
[2]Pontificia Universidad Católica del Ecuador, Escuela de Ciencias Biológicas, EC1701, Quito, Ecuador
[3]IRD, UMR G-EAU, 34196, Montpellier, France
[4]University of Copenhagen, Department of Biology, 2100, Copenhagen, Denmark
[5]IRD, UMR EGCE, 91198, Gif-sur Yvette, France

One impact of climate change is the rapid shrinking of glaciers, resulting in a reduction in glacial meltwater contribution to river flow in many glacierized catchments, with unknown consequences on the remarkable aquatic biodiversity of alpine valleys. A major issue in elucidating the ecological effects of shrinking glaciers relates to predicting biological community responses to modifications in glacier runoff. Observationally based predictions of these effects are abundant, but manipulative experiments are rare, especially for whole ecosystems.
To address this issue, we conduct a four-year flow manipulation where we experimentally simulate temporary flow reduction in a glacier-fed stream of the Ecuadorian Andes, a region where mountain glaciers are particularly sensitive to climate change. Using a Before-After-Control-Impacted design, we divert one-third of the glacial meltwater of a glacier-fed stream (manipulated) during an entire year while an adjacent similar stream (reference) remains undisturbed. We assess the response and resilience (capacity to return to pre-disturbance state) of benthic algal and faunal community composition and trophic structure to flow reduction consistent with glacier retreat predictions.
Compared to the reference stream, meltwater flow reduction significantly influences benthic fauna community composition in less than two weeks. This change in benthic faunal assemblage is mainly due to increased abundances of herbivorous taxa. Indeed, both algal and herbivore biomass significantly increase in the manipulated stream as a response to flow reduction. After flow recovery, the system requires 14-16 months to return to its pre-perturbation state.
Our experimental study provides unique insights into how glacially influenced rivers can be expected to respond to glacier retreat under global warming and therefore urges to further increase our understanding on how climate change will affect whole ecosystems. We found that reduction in glacier runoff rapidly induces a reorganization of benthic taxon assemblage, which requires twenty times longer returning to initial state. Resilience delay may be prolonged by competition exclusion of the dominant herbivore taxa that established during low flow conditions. Such shifts are most relevant to concerns of biodiversity conservation and ecosystem services of aquatic systems in both temperate and tropical mountains where many types of human-induced perturbations affect resilience.

P30-03 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
17:30 – 18:30 – Joffre Area (Level 1)

Tropical tree species' responses to temperature and precipitation changes: A transplant experiment at Mount Kilimanjaro

MARION RENNER[1], ANDREAS HEMP[2], MARKUS FISCHER[3]
[1]University of Bern, Plant Ecology, 3013, Bern, Switzerland
[2]University of Bayreuth, Plant Systematics, 95440, Bayreuth, Germany
[3]University of Bern, Plant Ecology, 3013, Bern, Switzerland

Climate and land cover changes are heavily impacting the world's ecosystems. Tropical forests provide crucial ecosystem functions and services, but how tropical trees will respond to the main components of climate change, i.e. temperature and precipitation, is poorly known. For trees, early stages in the live cycle, e.g. germination and seedling establishment are most sensitive to environmental changes and crucial for recruitment and population dynamics.
To study how tropical trees respond to temperature and precipitation changes, we germinated and grew 48 tree species from different vegetation zones between 800 and 3000 m a.s.l., under standard conditions in two experimental gardens at Kilimanjaro. One garden was located in the savanna zone at 880 m a.s.l. and the other in the montane vegetation zone at 1450. Furthermore, we applied a drought treatment in both gardens to study species' responses to drought under the different temperature regimes of the two gardens. We measured seed germination during 12 weeks and the performance of the emerging seedling after 3 and 6 months.
Initial results suggest, that germination success was significantly higher in savanna than in montane garden. While plant growth rate and performance was also higher in the hotter savanna garden, it depended also on water availability and trees were more negatively affected by drought in the montane garden than in the savanna garden. However, the opposite was found in leaf number, where drought caused a stronger decrease in the savanna garden.
Our results indicate that increased temperature may facilitate tree germination and seedling growth in the African tropics. Moreover, we show that the effects of drought on the trees change with ambient temperature, underlining the need to study the combined effects of climate change components.

P30-04 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
17:30 – 18:30 – Joffre Area (Level 1)

The use of manipulation experiments to understand tropical forest response to climate change.

PATRICK MEIR[1], MAURIZIO MENCUCCINI[2], LUCY ROWLAND[3], DAVID GALBRAITH[4], ANTONIO CL DA COSTA[5], PAULO BRANDO[6], TANA WOOD[7], LEANDRO FERREIRA[8], OLIVER BINKS[9], PATRICK MEIR[9]
[1]Australian National University, Research School of Biology, 2601, Canberra, Australia
[2]CREAF, ICREA, BA21, Barcelona, Spain
[3]Exeter University, Geography, EX1, Exeter, UK
[4]Leeds University, Geography, LE1, Leeds, UK
[5]Universidade Federal de Para, Geociencias, PA-555-10, Belem, Brazil(
[6]Woods Hole Research Centre, Biology, MA, Falmouth, USA
[7]USDA Forest Service, International Institute of Tropical Forestry, 2005, Rio Piedras, Puerto Rico USA

The utility of manipulation experiments for understanding and predicting ecosystem responses to habitat modification is universally acknowledged but has not been as widely practised in the tropics as elsewhere. This geographical contrast in investment reflects historical differences in available research resources, but it is at odds with the scientific need given the rapid and potentially large-scale response by tropical ecosystems to perturbations through climate, land use or biotic invasion. Changes in the physical environment are some of the most difficult to diagnose mechanism and effect for, purely through observational studies, because of the small incremental year-to-year changes observed in relation to the size of the predicted long-term perturbations. I describe the use of a long-term soil moisture reduction experiment in tropical rainforest to understand the process-level and stand-level responses by this ecosystem to drought and warming. The soil moisture manipulation treatment has been implemented at ecosystem-scale (1 ha) and is the longest running (>15 yrs) through-fall exclusion in tropical forest. This combination of attributes has led to unique insight into the sensitivity of rainforest to drought concerning, for example, physiological acclimation (photosynthetic capacity, respiration), water transport in trees and tree mortality. These findings would not have been possible without the scale and duration of this study. We integrate new outcomes from this experiment with a recent synthesis of tropical drought experiments to examine the advantages and disadvantages of focussed field-scale experiments, also considering the merits of using one or more treatment combination, the merits of short or long time periods, and thus the use of the manipulation approach for addressing global-change questions where many more driving variables than the specified treatment effect(s) are likely to co-vary.

P30-05 – S30 *Manipulation experiments for understanding tropical ecosystem responses to habitat modification*
17:30 – 18:30 – Joffre Area (Level 1)

Mapping fine-scale forest structure and tree spatial distribution in Borneo's secondary tropical forests

MARTIN SVATEK[1], JAKUB KVASNICA[1], MARTIN REJZEK[1], RADIM MATULA[1], ANNA HELANOVA[1], JAN SEBESTA[1], ROBERT EWERS[2]
[1]Mendel University in Brno, Faculty of Forestry and Wood Technology, 61300, Brno, Czech Republic
[2]Imperial College London, Faculty of Natural Sciences, Department of Life Sciences, SW7 2AZ, London, United Kingdom

Within the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah (Malaysian Borneo), we used a laser technology to study structure and fine-scale spatial distribution of trees in logged and fragmented tropical rainforest. Relative deforestation rate in South East Asia is the highest among any major tropical regions. In Borneo, most of the lowland dipterocarp forests have been already affected either by selective logging or conversion to the oil palm plantations. However, despite their crucial role in human-modified landscape, information on structure and fine-scale spatial distribution of secondary tropical forests remains scarce. While in primary tropical forests, manually measured permanent plots are a standard tool to study forest structure and dynamics; studies of secondary (logged and fragmented) forests with their dense undergrowth, majority of small trees and the need to capture fine-scale stem dynamics (instead of traditional tree dynamics) poses a new challenge for tropical ecologists.
We present a laser technology for mapping forest structure and fine-scale spatial distribution of trees, based on a combination of interconnected electronic devices and specialized Field-Map software (IFER, Jilove u Prahy, Czech Republic). The technology effectively captures tree positions to the nearest centimetre in three-dimensional space and allows mapping points, lines, polygons, deadwood, horizontal tree crown projections, vertical crown profiles, stem profiles and micro-topography of permanent plots. We used the technology to study fine-scale spatial structure of small trees with dbh ≥ 1 cm in logged and fragmented tropical rainforest within the Stability of Altered Forest Ecosystems (SAFE) Project in Sabah, Malaysian Borneo. The principles, advantages and the outcomes of the Field-Map technology are presented.

P33-03 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Do fruit-seed syndromes influence rates of attack by frugivorous insect communities across three tropical rain forests?

CHRIS DAHL[1], RICHARD CTVRTECKA[1], SOFIA GRIPENBERG[2], OWEN T. LEWIS[2], SIMON T. SEGAR[1], DOMINIC RINAN[3], JONA FILIP[3], JEROME DEBORA[3], ROLL LILIP[3], PITOON KONGNOO[4], MONTARIKA PANMENG[4], SUTIPUN PUTNAUL[4], MANAT REUNGAEW[4], THANA THONGROD[4], MARLENY RIVERA[5], GEORGE WEIBLEN[6], VOJTECH NOVOTNY[1], YVES BASSET[5]
[1]University of South Bohemia and Institute of Entomology, Biology Center of the Academy of Sciences of the Czech Republic, Ecology and Conservation Biology, 31-CZ 370-05, Ceske Budejovice, Czech Republic
[2]University of Oxford, Zoology, OX1 3PS, Oxford, United Kingdom
[3]New Guinea Binatang Research Center, Research and Conservation, 511, Madang, Papua New Guinea
[4]Center for Tropical Forest Science, Khao Chong Botanical Garden, 92170, Trang, Thailand
[5]Smithsonian Tropical Research Institute, Tropical Research, 0843–03092, Panama, Republic of Panama
[6]University of Minnesota, Bell Museum and Plant Biology, MN 55108, Minnesota, USA

ForestGEO is a global network of permanent forest plots established to study long term tropical and temperate forest ecosystem dynamics. These forest plots are re-surveyed every 5 years intervals. Until recently the wealth of plant data from ForestGEO plots has not been used by entomologists. We compare fruit/seed feeding insect predators in three ForestGEO rain forest plot sites, Panama, (Barro Colorado Island = BCI), Thailand (Khao Chong = KHC) and Papua New Guinea (Wanang = WAN). We used a standardized protocol and reared fruit/seed feeding insects in these forest plots. Insect feeding on fruits and seeds reduce the survival rate and mortality of seedlings thus influence plant species diversity and composition. At these sites, we overall surveyed 1,680 kg of fruits from 1,093 plant species and reared 80,104 insects from them. We will use these data to compare insect predation reared from fruit/seed in three tropical forest communities, to assess the rates of attack by insects on each of the fruit syndrome. Further, discuss whether there is a relationship between fruit syndromes and insect seed predators that are amenable to Janzen-Connell density dependent hypothesis. Finally, we will explore the relationship between local tree abundance and the attack rate on plant bearing fruits.
Key words: ForestGEO, rain forest, seed feeding insect, tropic

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P33-04 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Pierid butterflies and legume hostplants in urban areas of southern Florida

SUZANNE KOPTUR[1], ANDREA SALAS[1], HIPOLITO FERREIRA PAULINO NETO[2]
[1]Florida International University, Biological Sciences, 33199, Miami, USA
[2]Universidade de Sao Paulo, Brazil

Senna species are major hostplants for sulphur butterflies in and around Miami, Florida. The cloudless sulfur (Phoebis sennae) and the orange-barred sulfur (Phoebis agarithe) utilize native and ornamental species of Senna, as well as Cassia and Chamaecrista. We collected caterpillars from native and ornamental species of these genera in gardens and roadside landscapes in urban areas of Miami, over several years, and reared them to compare levels of parasitization of the larvae. Our hypothesis: caterpillars on native hostplants experience greater attack, as parasitoids have coevolved with herbivores on species native to the area. Caterpillars on both native and ornamental hostplant species were parasitized, proportionally more for those feeding on ornamental hostplant species! The same richness of parasitoids (Hymenoptera and Diptera) was observed on both, though Diptera were more commonly reared from native hostplant species. These hostplants also possess extrafloral nectaries, and ants and other predators attracted to the nectar may defend the plants and limit the amount of damage and presence of caterpillar herbivores by their presence and actions, as has been demonstrated on native congeneric hostplant species in surrounding natural areas.

P33-05 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Mixed pollination syndromes in two Mexican Drymonia species: transitional forms or historical constraints?

SILVANA MARTEN-RODRÍGUEZ[1], ERANDI RAMÍREZ-AGUIRRE[1], JUAN FRANCISCO ORNELAS[2]
[1]Universidad Nacional Autónoma de México, Escuela Nacional de Estudios Superiores, 58190, Morelia, México
[2]Instituto de Ecología, A.C., Biología Evolutiva, 91070, Xalapa, México

Background: Pollination syndromes are suites of floral characters that have been associated with selection by most frequent and effective pollinators. However, floral traits sometimes fit more than on syndrome, and floral visitors often do not correspond with predicted pollinators. These cases may reflect historical/developmental constraints, transitional stages in pollination system evolution, or anthropogenic disturbance. This study assessed the correspondence between floral traits and visitors of two epiphytic Drymonia species with mixed floral phenotypes.
Methods: we studied of D. strigosa and D. oinochrophylla Los Tuxtlas Biosphere Reserve in Mexico for two consecutive years. We measured floral traits and nectar production to characterize floral syndromes, and conducted pollinator observations to estimate floral visitation. We also determined breeding systems through crossing experiments.
Results: Floral traits mostly corresponded to ornithophily (D. strigosa) and to melitophily (D. oinochrophylla); however, poricidal anther dehiscence (found in both species) has traditionally been associated with pollination by bees, while high nectar production (found in D. oinochrophylla) have been associated with bat pollination. Principal pollinators were as predicted by most floral traits: hummingbirds in D. strigosa and bees in D. oinochrophylla; secondary pollinators accounting for < 20% of the visits were also observed in both species, as well as nectar robbers and thieves. Both species were self-compatible but only D. strigosa had high potential for autonomous self-pollination.
Discussion: Overall results suggest that the lack of fit of certain traits to classic syndromes is not associated with transitional pollination stages but rather reflects a historical constraint. Poricidal anthers (and possibly bee pollination) are ancestral in the genus, which likely explains the presence of this anther type in hummingbird-pollinated D. strigosa. Interestingly secondary pollinators of D. strigosa species were bees. On the other hand, D. oinochrophylla showed mixed floral traits traditionally associated with bee and bat pollination. The absence of expected bat visitors to the highly rewarding flowers of D. oinochrophylla is still unexplained, and may reflect untested effects of allometry (large nectaries developing in association with large corollas) or anthropogenic disturbance.

P33-06 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Bee flora and pollen grains study for the Online Pollen Catalogue Network: basis for plant-pollinator interactions research

CLAUDIA SILVA[1], BRENO FREITAS[2], SORAIA BAUERMANN[3], ASTRID KLEINERT[4], VERA IMPERATRIZ-FONSECA[5], MÁRCIA MAUÉS[6], PATRÍCIA ALBUQUERQUE[7], JAÍLSON NOVAIS[8], VAGNER TOLEDO[9], BETINA BLOCHTEIN[10], EVA SARMENTO[11], CRISTIANE KRUG[12], JOSÉ CURE[13], VANIA ESTEVES[14], CLAUDIA MENDONÇA[15], BLANDINA VIANA[16], FRANCISCO SANTOS[17], ISABEL SANTOS[18], ANTONIO SARAIVA[19]
[1]Universidade de Sao Paulo, Departamento de Ecologia, 05508090, São Paulo, Brasil
[2]Universidade do Ceará, Departamento de Zootecnia, 60356000, Fortaleza, Brasil
[3]Universidade Luterana do Brasil, Laboratório de Palinologia, 92425900, Canoas, Brasil
[4]Universidade de Sao Paulo, Departamento de Ecologia, 05508090, São Paulo, Brasil
[5]Universidade de Sao Paulo, Departamento de Ecologia, 05508090, São Paulo, Brasil
[6]Embrapa Amazônia Oriental, Setor de Entomologia, 66095100, Belém, Brasil
[7]Universidade Federal do Maranhão, Departamento de Biologia, 65080805, Maranhão, Brasil
[8]Universidade Federal do Sul da Bahia, Departamento de Ciências Ambientais, 45810000, Porto Seguro, Brasil(
[9]Universidade Estadual de Maringá, Departamento de Zootecnia, 87020900, Maringá, Brasil
[10]Pontifícia Universidade Católica do Rio Grande do Sul, Faculdade de Biociências, 90619900, Porto Alegre, Brasil
[11]Universidade Federal do Vale do São Francisco, Departamento de Zootecnia, 56300000, Petrolina, Brasil
[12]Embrapa Amazônia Ocidental, Setor de Entomologia, 69010970, Manaus, Brasil
[13]Universidad Militar Nueva Granada, Faculdad de Biología Aplicada, 49300, Cajicá, Colômbia
[14]Museu Nacional do Rio de Janeiro, Departamento deBotânica, 20940040, Rio de Janeiro, Brasil
[15]Museu Nacional do Rio de Janeiro, Departamento de Botânica, 20940040, Rio de Janeiro, Brasil
[16]Universidade Federal da Bahia, Instituto de Biologia, 40170210, Salvador, Brasil
[17]Universidade Estadual de Feira de Santana, Departamento de Ciências Biológicas, 44036900, Feira de Santana, Brasil
[18]Universidade de São Paulo, Departamento de Ecologia, 05508090, São Paulo, Brasil
[19]Universidade de São Paulo, Departamento de Engenharia de Computação e Sistemas Digitais, 05508010, São Paulo, Brasil

Introduction: More than 90% of the flowering plants depend on pollinators for their reproduction. In agriculture, pollination is also highly important, as biotic pollination improves the quantity or quality of fruits and seeds. The annual global food production that depends of pollinators is estimated between US$235 to US$577 billion. The maintenance of natural areas that are used in the diet of the bees is highly recommended. Therefore, the identification of the plants used in the diets of bees, both adult and immature bees, has become one of the first steps in the management of natural and cultivated areas.
Material and Methods: There are basically two ways to identify plants used in the bee's diet. The first is by direct observation of the bees collecting resources from the flowers, and the second is by analysis of pollen deposited on their bodies, on their corbiculae or pollen brushes, of pollen material in the cells used to raise the young, of pollen storage pots, or even in faeces deposits found in or outside the nests. In this study, we used the pollen grains to identify the plant species used in the bee's diet. Thus, we constructed pollen libraries (reference pollen collections) of the flora in the different study areas and constructed a tool to organize and identify the plant species using an interactive key with flowers and pollen morphological characters. The data will be available in the Online Pollen Catalogue Network (RCPol – Rede de Catálogos Polínicos online) that is being developed.
Results and discussion: We have at this moment more than 500 plants species introduced in the RCPol that were identified in the diet of the bees. Currently we already have eight pollen collections participating of the network, and ten others are expected to join in the next two years. The online network allows access to interactive keys with pollen and plant descriptors, to plant species webpages that describe the main characteristics of the species, and to the specimen data, at the collection level. The study of pollen allows identification of not only the plant species used, or the most important ones, but also foraging routes, periods of resource shortages in the field and the interpretation of networks of generalist and specialist interactions established between bees and plants. Palynology has been a complementary science, supporting studies on pollinator's management and conservation, especially bees, in natural ecosystems and agroecosystems.

P33-07 – S33 *Free session: The conservation of plant-animal interactions in a changing world*
17:30 – 18:30 – Joffre Area (Level 1)

Rewiring of ant-plant mutualistic networks in tropical secondary forests is governed by land-use history

THIAGO IZZO[1], CARLOS PERES[2], HERALDO VASCONCELOS[3]
[1]UFMT, Instituto de Biologia, 78060-900, Cuiabá, Brazil
[2]UEA, Schoool of Environmental Sciences, NR4 7TJ, Norwich, UK
[3]UFU, Instituto de Biologia, 38405-320, Uberlandia, Brazil

Unprecedented tropical deforestation rates often result in vast areas of young second growth, following agricultural abandonment. The importance of these secondary forests as a 'safety-net' for tropical biodiversity in primary forests has received considerable attention in the recent literature. However, few studies have investigated how landscape structure and land-use history govern the functional maintenance of mutualisms in tropical secondary forests. Here, we examine how changes in land use and forest landscape context affect the structure and specificity of ant-plant mutualistic networks. The study was conducted at three former cattle ranch sites in Central Amazonia. In 2002 and 2003, we surveyed 27 transects, eight of which in mature forests and 19 in secondary forests of different land use histories. Land use was defined as the number of times each forest site had been clear-cut and burned. All individual ant plants were identified and surveyed for colonizing ants. We them built individual ant-plant matrices and calculated their Specialization (H') and Modularity (Q) indices. Furthermore, we determined the "Module dissimilarity" by summing all mature forest sites collapsed into a single matrix and determining the components of ant-plant modules of this matrix. We then calculated the Bray-Curtis similarity between the modules in each individual matrix and those found in the overall matrix. The composition of both ant and plant species was affected by the recurring number of fire events but not by the distance from primary forest or the geographic distance among sampling plots. Ant composition was strongly related to both plant composition and land-use history. Plant composition, combined with land-use history, was also explained the specialization and the modularity of mutualistic networks. On the other hand, the number of empty plants (not hosting ants) and the modular dissimilarity was explained by number of recurrent fires alone. Our results shows that the recolonization of a given area by an ant-plant system and the structure of mutualistic networks is conditional upon the prior colonization by the plant partner. Such colonization events are affected by both dispersal limitation and land use history. Patterns of network metrics are associated with host plant species composition, whereas the recovery of compositional similarity in modules typical of primary forests is strongly associated with land-use history.

P34-01 – S34 *Free session: Tropical forest ecology, conservation and management*
17:30 – 18:30 – Joffre Area (Level 1)

A conceptual framework of causes of the science-practice gap in Ecology

DIANA GARCIA[1], CARLA MORSELLO[2], CHARBEL EL-HANI[3], RENATA PARDINI[1]
[1]Universidade de São Paulo, Instituto de Biociências, 05508-090, São Paulo, Brazil
[2]Universidade de São Paulo, Escola de Artes, Ciências e Humanidades, 03828-000, São Paulo, Brazil
[3]Universidade Federal da Bahia, Instituto de Biologia, 40170-290, Salvador, Brazil

Background Despite strong confidence in science to help confront societal challenges, many disciplines struggle to assure scientific knowledge is applied to real world problems. This gap between science and practice has been recognized since the 1970s, but it has only recently come to the forefront of scientific debates in Ecology. A variety of causes of this gap has been proposed, but we still lack a comprehensive framework organizing them into common domains, enabling us to understand and propose solutions to this multifaceted problem. Here, we draw on an extensive bibliographic search and techniques from the social sciences to organize into a conceptual framework the causes of the science-practice gap in Ecology.
Method We selected 122 articles discussing the causes of the science-practice gap in Ecology and, from these, 1564 sentences describing them. Eight scientists produced their own classification of causes by sorting a sample of sentences by perceived similarity, and discussed advantages of different classifications. One classification was chosen and refined to include all sentences found in the literature, producing the final conceptual framework.
Result The framework contains 48 categories divided into three major perspectives on which knowledge or actors are important in the science-practice interface, and thus on which processes link science and practice. The "One Knowledge" perspective (most common) assumes only scientific knowledge is important to support practice, establishing a linear flow of knowledge from science to practice, and considers knowledge generation, communication and/or use are usually flawed. The "Two Knowledges" perspective assumes both science and practice should contribute to support practice, establishing a process of knowledge integration, which for several reasons infrequently occurs. The "One Actor" perspective (very rare) assumes scientists should put their results into practice, but they rarely do so.
Conclusion In addition to emphasizing the science-practice gap in Ecology as a multifaceted problem with a variety of causes, our framework captured different perspectives on the science-practice interface that parallel those in other fields, and identified which processes linking science and practice in Ecology are inefficient. We suggest that multiple solutions enhancing both the flow of knowledge and the interactions between science and practice are needed, and that some causes are specific to the ecological arena.

P34-02 – S34 *Free session: Tropical forest ecology, conservation and management*
17:30 – 18:30 – Joffre Area (Level 1)

Impacts of thermal acclimation & adaptation of photosynthesis on future land carbon storage

LINA M MERCADO[1], BELINDA E MEDLYN[2], CHRIS HUNTINGFORD[3], STEPHEN SITCH[1], PRZEMYSLAW ZELAZOWSK[4], JENS KATTGE[5], PETER M COX[6]
[1]University of Exeter, College of Life and Environmental Sciences, EX4 4PS, Exeter, UK
[2]University of Western Sydney, Hawkesbury Institute for the Environment, 2751, New South Wales, Australia
[3]Centre for Ecology and Hydrology, Climate systems, OX10 8BB, Wallingford, UK
[4]University of Warsaw, Centre of New Technologies, 02-097, Warsaw, Poland
[5]Max Planck Institute for Biogeochemistry, Functional Biogeography, D-07745, Jena, Germany
[6]University of Exeter, College of Engineering, Mathematics and Physical Sciences, EX4 4QF, Exeter, UK

Plants are adapted to their climate of origin and in order to mitigate stress they can adjust their characteristics to new thermal conditions; this thermal plasticity is called thermal acclimation. A key factor that affects plant's resilience to future climate change is the ability of plant photosynthesis to acclimate to future temperatures. Most of the global models that are used to predict future vegetation and climate-carbon interactions do not account for these effects.
We quantify the single and combined regional impacts of adaptation and acclimation using a coupled climate – carbon cycle model driven with patterns of climate change based on 22 global climate models.
We estimate an enhancement in the global land carbon sink of between 19 and 77 PgC by 2100 due to thermal acclimation of photosynthesis. The effects in the tropics dominate, with a mean enhancement of tropical land carbon storage of 13.7 % by 2100 due to thermal acclimation. Also, acclimation reduces the sensitivity of climate-carbon cycle models to climate change, reducing (by 9%) the spread in global model projections in 2100.
Contrary to other studies, our results suggest that thermal acclimation of photosynthesis makes tropical carbon less vulnerable to warming.

P34-03 – S34 *Free session: Tropical forest ecology, conservation and management*
17:30 – 18:30 – Joffre Area (Level 1)

Functional connectivity for small mammals in a logged Bolivian forest

STODDARD MARGO A.
University of Florida, Department of Wildlife Ecology and Conservation, 110 Newins-Ziegler Hall 110430, FL 32611-0430, Gainesville, USA

Background: In the Amazon, selective logging results in a patchwork of forest stands and gaps at various stages of regeneration, which can influence structural and functional connectivity for forest-dependent organisms. How organisms perceive and respond to changes in habitat structure can affect their behavioral decisions regarding movement. Woody vines may be especially important in explaining how small mammals make these decisions.
Methods: I evaluated the importance of vines and vine tangles for terrestrial and arboreal small mammals in a transitional Amazonian forest in eastern Bolivia. Based on live captures of >1100 individuals (3 main species) from >10K trap nights at ground, shrub, and canopy levels in sites representing a range of logging disturbance, I compared abundance of animals with the availability of food (invertebrates) and vine density. To determine which substrates were used selectively, I followed movements of individuals using spool and line. Finally, I measured foraging in vine tangles v. open areas in stands subjected to normal or intensive timber extraction levels to determine if predation risk perceived by small mammals is associated with vines or other cover.
Results: Captures of the main terrestrial species (Euryoryzomys nitidus) decreased and those of the main shrub and canopy species (Oecomys & Micoureus spp) increased as % cover vines <5 m in height increased in the study area. Only for E. nitidus was abundance related to food, with abundance highest at intermediate insect biomass values. Food abundance was not related to measures of vine density. However, vines were selectively used as movement substrate for shrub and arboreal species, and small mammals foraged more (i.e., perceived less risk) beneath vine tangles than in open sites, but only in intensively-logged forests.
Conclusion: In forests disturbed by logging, vines are important for movement of shrub and arboreal marsupials, and tangles may play an important role as refugia for some species. These results argue against vine removal prior to harvest, although higher intensity logging and subsequent growth of tangles may benefit some species.

P34-04 – S34 *Free session: Tropical forest ecology, conservation and management*
17:30 – 18:30 – Joffre Area (Level 1)

Community-based management: Linking mangrove conservation and sustainable livelihoods

FAJARDO PAOLA
Department of Geography, McGill University, Montreal, Canada

Mangrove forests provide vital ecosystem services to millions of people, including wood, a renewable natural capital, which is the primary source of energy and construction material for several coastal communities in developing countries. Mangrove loss and degradation are occurring at alarming rates. In some regions, unregulated and unsustainable mangrove wood harvesting are important causes of degradation. Despite community-based harvesting is a common practice few successful case studies are known and studies evaluating its sustainability and effect on different ecosystem services are lacking. Therefore, my research explores the sustainability of regulated community-based mangrove harvests by evaluating its effect on forest structure, wood stocks and natural regeneration. For this study, I identified the most intensively harvested and the most conserved mangrove natural stands in West Mexico, where local communities have been managing mangroves for decades for both domestic and commercial purposes. In contrast to mangrove over-harvesting, industrial and illegal logging scenarios elsewhere, authorized community-based forestry activities in the area follow a unique approach including four management units: conservation, wood production, protection and restoration. Diameter-size classes analysis showed that tree density was not significantly different between harvested and non-harvested stands. Despite wood volume was higher in non-harvested stands, selective harvesting is conducted only in small production areas allowing soil and biodiversity conservation in the majority of mangrove-forested areas. Nevertheless, canopy cover and natural regeneration were higher in harvested stands indicating that community-based mangrove wood harvesting contributes to enhancing natural regeneration, securing wood stocks in the long-term and preserving landscape connectivity. Consequently, the spatial and temporal trade-offs of mangrove harvesting and the provision of multiple ecosystem services are minimal. Overall, my research findings indicate that community-based mangrove management could be a sustainable win-win solution to conserve mangrove forests and their ecosystem services alongside its direct use while providing local livelihoods and reducing illegal harvesting.

P35-01 – S35 *Plant diversity and endemism in the western ghats-sri lanka biodiversity hotspot: past, present and future*
17:30 – 18:30 – Joffre Area (Level 1)

Phylogeography of a critically endangered and endemic tree of Western Ghats reveals responses to quaternary dynamics

RAJASRI RAY[1], TV RAMACHANDRA[1], AVIK RAY[2]
[1]Indian Institute of Science, Center for Ecological Sciences, 560012, Bangalore, India
[2]Ashoka Trust for Research In Ecology and Environment (ATREE), Suri Sehgal Centre for Biodiversity and Conservation, 560064, Bangalore, India

Background: Earth's biota experienced a major rearrangement during quaternary ice age. Studies on Euro-American flora and fauna has yielded critical insight into the biotic responses to ice age; i.e. identification of glacial refugia, colonisation of new landscapes, divergence and speciation. However, response of tropical diversity to Quaternary ice age remains mostly enigmatic due to lack of phylogeographic studies. In the current study, we investigated the genealogies of a critically endangered and endemic tree of Western Ghats, Syzygium travancoricum, to shed light on its quaternary dynamics.
Method: At total of 110 individuals were collected from its entire range across Western Ghats. Two nuclear and two chloroplast markers were employed to estimate population structure, spatial distribution of genetic diversity, genetic clusters and to infer population history. In addition, ecological niche model was integrated to uncover the distribution changes in the past.
Result: Genetic diversity is relatively higher (35) in nuclear markers with rare polymorphisms whereas chloroplast markers demonstrate only seven haplotypes in entire distribution range. The Western Ghats populations appear to be subdivided showing moderate (nuclear Fst= 0.07) to high structure (chloroplast Fst= 0.37). Cluster analyses reveal multiple genetic groups (at least two). Investigation of population history brings about a population split during ice age (approx. 50,000-100000 years) with subsequent rapid expansion as the most probable scenario. Niche model predicts the major change in the distribution from last interglacial.
Discussion and conclusion: Impact of Quaternary period on Western Ghats plants remains largely under explored. The current study uncovers the dynamics of an endemic tree of Myratceae family during ice age. It shows high differentiation along north-south boundary evoking isolated populations with least gene flow. Possession of rare haplotypes is also indicative of fixing of certain mutations due to drift perhaps during the course of fragmentation and divergence. The distribution of genetic variation and rare alleles complemented with reconstructed past niche may indicate that the plant survived Quaternary climatic perturbation in two isolated refugia in the north and south of its distribution range likely followed by a rapid expansion in the post-glacial retreat phase.

P36-01 – S36 *Free session: Biodiversity and palm oil plantations*
17:30 – 18:30 – Joffre Area (Level 1)

The conservation scope of sustainability tools and initiatives in the oil-palm industry: Scales, synergies and gaps

JOHN GARCIA ULLOA[1], JABOURY GHAZOUL[1], LIAN PIN KOH[1]
[1]ETH Zurich, Department of Environmental Systems Science, 8092, Zurich, Switzerland
[2]The University of Adelaide, School of Earth and Environmental Sciences, 5005, Adelaide, Australia

Oil-palm agriculture has been at the center of conservation efforts in the tropics, because of the large-scale deforestation associated to the rapid expansion of this crop. Public pressure has precipitated the creation of various sustainability initiatives aiming to minimize social and environmental impacts of current and future expansion of the oil-palm industry. These initiatives include certification standards (e.g. RSPO, ISPO), zero-deforestation commitments from important industry actors, deforestation moratoriums, and methodological frameworks to identify and prioritize the conversion of areas of social and environmental importance (e.g. HCV, HCS, HCS+). Although many of these initiatives have had the support from the main stakeholders in the sector, there is a tacit agreement that their success has been limited and many question their effectiveness and credibility.
We conducted a policy analysis on how these different initiatives address the various mechanisms that can result in biodiversity changes in palm-oil producing regions. We identified policy synergies and gaps that may enhance or undermine the effectiveness of these initiatives. We found that habitat loss is the mechanism of biodiversity loss better addressed by the combined implementation of these initiatives, however, their impact is limited to the plantation and thus ineffective at broader scales. Other mechanisms such as fragmentation, which operate at wider spatial and temporal scales that go beyond the plantation, can also result in species declines in palm-oil producing landscapes and regions. We argue that current sustainability initiatives in the oil-palm industry fail to address these issues, which compromises their effectiveness for conservation.

P36-02 – S36 *Free session: Biodiversity and palm oil plantations*
17:30 – 18:30 – Joffre Area (Level 1)

Cumulative impacts of tropical agricultural commodities production

LISA KING
ETH Zurich, Ecological Management, 8092, Zurich, Switzerland

Tropical agricultural commodities are prone to boom-and-bust cycles of production, with crops often planted on deforested lands and subsequently abandoned or replaced as plantations age or yields become severely limited by disease. Many countries have explicit goals of increasing production of several crops to increase foreign exchange or to meet domestic demand. In Indonesia for example, even amidst the exponential increase in land under oil palm production, the area of rubber harvested has doubled in the last 20 years and the country is currently the third largest producer of cocoa globally. The expansion of crops such as oil palm, cocoa, and rubber has been assessed on a variety of national or local case study levels but the cumulative impacts across landscapes remains understudied as new forest frontiers are opened up and undergo transitions between different land systems.
The project focused on modeling the expansion of three perennial crops in Indonesia, oil palm, rubber and cocoa, under different governmental and business policy scenarios. These three crops have similar climatic requirements and lifecycle durations, and are grown in a variety of settings, from monocultures to diverse agroforestry systems. Biophysical suitability maps of the crops were compared and models of expansion were developed considering global and domestic projections, along with the differing international standards of production for these crops. The resulting scenarios were analyzed for fragmentation and connectivity, with the aim of understanding the cumulative biodiversity implications. As global businesses increasingly make commitments to sustainably source and produce tropical agriculture commodities, the competing demands for land need to be explicitly modeled and assessed to ensure environmental and social impacts are mitigated and not simply shuffled around between commodities.

P37-01 – S37 *Free session: Tropical ecology and society in African ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Baboon Spider Atlas: leveraging citizen science for charismatic creatures

IAN ENGELBRECHT[2], DIMITRI KAMBAS[2], HEATHER CAMPBELL[1]
[1]University of Pretoria, Zoology and Entomology, 0083, Pretoria, South Africa
[2]Baboon Spider Atlas, Zoology and Entomology, 0083, Pretoria, South

Background: Basic species distribution data is critical for conservation purposes like Red Listing and spatial conservation planning. Baboon spiders are large, long-lived mygalomorph spiders with limited tolerance for environmental disturbance. They are protected by law in several southern African countries, but are in demand by collectors in the international pet trade. Despite their size and charisma they are poorly documented, hampering conservation initiatives. The goal of the Baboon Spider Atlas is to document the diversity and distribution of all southern African baboon spider species using citizen science.
Methods: The project gathers photographic specimen records through an online Virtual Museum hosted at the Animal Demography Unit, University of Cape Town. Records from the public are collected through Facebook, Twitter and the project website, www.baboonspideratlas.co.za. In addition, fieldwork is conducted for collection purposes and to improve coverage of undersampled areas. Museum specimens are also being added to the project database. A library of specimen photographs is being compiled for reference and publication purposes, and a tissue bank is being developed to support molecular taxonomy. Where necessary, taxonomic work will describe new species and resolve questionable species boundaries.
Results: Since its inception over two years ago, the project has assembled one of the largest locality record databases for baboon spiders in the region, rivalling and expected to surpass the largest museum specimen collections soon. Several new species have been discovered and surprising distribution records are frequently submitted. New information on species biology is being recorded, including information on range restricted species, and those with highly specialised habitat requirements.
Discussion: Our results show that baboon spider diversity is significantly underestimated. Despite their poor representation in specimen collections baboon spiders are a common and important predator in many ecosystems. Illegal harvesting for the pet trade may be less of a threat than previously thought, whereas alternative threats are posed by habitat destruction and climate change. This project showcases the value of citizen science for documenting biodiversity, and has resulted in a significant improvement of our understanding of baboon spiders, which will ultimately result in production of an Atlas within 5 years.

P37-02 – S37 *Free session: Tropical ecology and society in African ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

A comparative assessment of cultural ecosystem services provision in three protected East African rainforests using photoseries analysis

DAVID ODEE, EMMANUEL MAKATIANI, JAMES GITU, JAMES WERE, CHARLES ODUOR, MILTON ESITUBI, JOHN GICHERU, JOHN OCHEIN
Kenya Forestry Research Institute (KEFRI), Biotechnology Laboratory, 00200, Nairobi, Kenya

Background: Tropical rainforests are renowned for their immense biodiversity and global importance in provisioning, regulating, supporting and cultural ecosystem services. An understanding of the trade-offs and how these ecosystem services are provided is crucial for effective management of tropical forests fragments, especially those exposed to high human pressures. Cultural ecosystem services (CES) are integral to the management of protected forests, yet they have received relatively less scientific attention because of the high cost (time, personnel and financial) associated with the widely used traditional socio-ecological methods of assessment. Here, we report the utility of the new photoseries analysis method to assess CES in three protected East African rainforests.
Methods: We analysed CES provision using geo-tagged digital images available online on the Flickr web platform, and taken at three East African tropical rainforests, namely Kakamega-Nandi forest (Kenya), and Mabira and Budongo forests (Uganda). All three forest ecosystems are medium-sized, surrounded by mainly smallholder agricultural communities, and are subjected to varying management plans. The main ecosystem services analysed were aesthetic value and recreational activity.
Results: Flickr searches returned a total of 128, 365 and 1260 photographs taken at Kakamega-Nandi Forest and Budongo and Mabira forests, respectively. The majority of photographs depicted aesthetic value associated with wildlife. Overall, the Flickr photographs segregated the aesthetic and recreational activity usage among the three forest ecosystems.
Discussion: Although comparable in size and protection status, there were more photographs uploaded at Mabira forest ecosystem reflecting higher visitation rates than the other two sites. It is postulated that Mabira's diverse biophysical characteristics such as forests, wildlife and water bodies provide a range of popular visual attractions and recreational activities, e.g. as water sports. However, other factors such as accessibility, infrastructure and management strategies may also explain the observed differences among the three forest ecosystems.
Conclusion: Use of geo-tagged photographs is a rapid CES assessment tool that could be used to complement traditional socio-ecological methods to improve implementation and management plans of threatened tropical forest ecosystems.

P37-03 – S37 *Free session: Tropical ecology and society in African ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Genetic evidence for hunter-gatherer-induced distribution of wild yams (Dioscorea praehensilis) in southeastern Cameroon

HIROKAZU YASUOKA[1], LAURE BENOIT[2], NORA SCARCELLI[3]
[1]Kyoto University, Center for African Area Studies, 6068501, Kyoto, Japan
[2]CNRS, Centre d'Ecologie Fonctionnelle et Evolutive, 34293, Montpellier, France
[3]IRD, UMR DIADE, 34394, Montpellier, France

Introduction: Wild yams (Dioscorea spp.) are indispensable food that sustain hunter-gatherer subsistence in African rainforests. However, the previous studies argued that their distribution might have expanded under human influences, e.g. shifting cultivation. If so, hunter-gatherer subsistence there was hardly viable before farming. On the contrary, there is a report that observed dense yam patches established by Baka Pygmy's foraging camps. To examine whether it can be generalized, genetic analyses were carried out about yam clusters regenerated after the camps.
Methods: Study sites were located near a village inhabited by 160 Baka, southeastern Cameroon. They often carry out foraging camps participated by 50-100 people for 2-3 months and consume large amounts of wild yams. In cooking yams, tuber pieces are discarded and yams regenerate from them. In 2012, all the yam individuals in 5 campsites of 1-10 years later of abandonment were collected. Among 5 species D. praehensilis that covered the largest part of the samples were selected for analysis. From 122 samples, 7 locus of micro satellites were extracted, and based on their polymorphisms a genealogical tree was constructed. The deviations of heterozygote rates from the Hardy-Weinberg Equilibrium (HWE) were also tested.
Results: The genetic structure expected from the polymorphisms showed little correspondences to the campsites, with very weak differentiation indices from each other. It indicates the samples were extracted from a common pool of plural genetic populations. On the other hand, for observed heterozygote rates, significant deficits from the expected rates on the HWE were confirmed for all the site averages and all the locus averages, a general factor in which is the samples are composed of different genetic groups.
Discussion: The above factor in the deficits is highly probable because the sampled yams were regenerated from tubers brought from different gathering places into the sites. Also considering the samples are a part of a common pool of plural genetic populations, the HWE is unlikely to be maintained for the whole populations from which the Baka gathered tubers. This means crossbreeding between patches hardly occurred though possible within the clusters. It is thus likely that the wild yam distributions in the area was established through vegetative reproductions induced by the tuber consumptions, without significant effects of seed dispersals that could achieve the HWE.

P39-01 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
17:30 – 18:30 – Joffre Area (Level 1)

A permanent monitoring network for N-fluxes in different forest types in the central Congo Basin

BAUTERS MARIJN[1], VERBEECK HANS[2], CIZUNGU LANDRY[3], MUJINYA BASILE BAZIRAKE[4], BOYEMBA FAUSTIN[5], BAERT GEERT[6], VERHEYEN KRIS[7], BOECKX PASCAL[1]
[1]Ghent University, ISOFYS Isotope Bioscience Laboratory, 9000, Gent, Belgium
[2]Ghent University, CAVElab Coputational and Applied Vegetation Ecology, 9000, Gent, Belgium
[3]Université Catholique de Bukavu, Faculty of Agronomy, BP285, Bukavu, DR Congo
[4]University of Lubumbashi, Department of General Agricultural Sciences, Lubumbashi, DR Congo
[5]Université de Kisangani, Faculté des Sciences, BP2012, Kisangani, DR Congo
[6]Ghent University, Department of Applied Biosciences, 9000, Gent, Belgium
[7]Ghent University, Forest and Nature Lab, 9090, Gontrode, Belgium

Characterization of biogeochemical processes in a variety forest types is vital to understand the interaction of forests with their changing environment. Accurate projections of future net forest growth and terrestrial CO2 uptake necessitate an improved understanding on nutrient cycles and how these are coupled to the carbon (C) cycle in forests. This holds especially for tropical forests, since they represent about 40–50% of the total carbon that is stored in terrestrial vegetation, with the Amazon basin and the Congo basin being the largest two contiguous blocks. However, due to political instability and reduced accessibility in the central Africa region, there is a strong bias in scientific research towards the Amazon basin. Consequently, central African forests are poorly characterized and their role in global change interactions shows distinct knowledge gaps, which is important bottleneck for all efforts to further optimize Earth system models explicitly including this region. Research in the Congo Basin region should combine assessments of both carbon stocks and the underlying nutrient cycles which directly impact the forest productivity. We set up a unique permanent monitoring network for carbon stocks and nitrogen fluxes in different forest types spread over the central Congo Basin, which is now operative. Preliminary results show a specific behavior of forest nutrient cycles in this area. This project aims for capacity building, stimulating local collaboration and generating a unique dataset that will serve modelers, biogeochemists and ecologists.

P39-02 – S39 *Capacity building for conservation and sustainable use: challenges and solutions to measuring impact*
17:30 – 18:30 – Joffre Area (Level 1)

Measuring the psychological aspects of long-term capacity for biodiversity conservation

KAYLA CRANSTON
Antioch University New England, Environmental Studies Department, 03431, Keene, USA

Human capacity has become the centerpiece of recent attempts to strengthen regional biodiversity conservation and international organizations usually aim to increase this capacity through education and training. While many practitioners will agree that these trainings presumably have a psychological effect that may benefit long-term local action toward conservation goals, they also seem resigned to accept that these effects are difficult if not impossible to measure, especially within diverse cultures. The common result is a perfunctory evaluation of observable behaviors or basic knowledge, which may be easy to count but undoubtedly fail to represent the nuance of the complex psychological variables associated with long-term human action. In this presentation, I offer a quantitative instrument I have created to measure psychological capacity for biodiversity conservation within diverse cultures and describe the results of a study I've conducted to identify exactly which aspects of this human capacity are correlated with objective indicators of biodiversity conservation success. The result is a easy to administer, psychologically valid measurement that can be used to evaluate the effectiveness of education and training programs to build long-term human capacity for biodiversity conservation.

P40-01 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
17:30 – 18:30 – Joffre Area (Level 1)

Carbon and water economy are decoupled in the Atlantic forest (São Paulo, Brasil)

MAURO MARABESI1, FABIO FERNANDEZ[2], HELOISA BRUNO[2], CARLOS JOLY[1], MARCOS AIDAR[2]
[1]UNICAMP, Botany, 055, Campinas, Brazil
[2]Institute of Botany, Physiology and Biochemistry, 055, São Paulo, Brazil

Background: Rainforests account for 34% of its gross primary productivity and around of 50% of plant total carbon stocks. The Brazilian Atlantic Forest (BAF) is considered as a major Hotspot for biodiversity conservation due its high endemism, diversity and threat (only 12% of its original area and highly fragmented). To understand better BAF functionality we need further knowledge on functional traits of the species that occurs in the different plant physigonomies and successional statues linking community structure and ecosystem function. This study aims to examine a group of functional traits of the main species of four areas of Atlantic Montane Forest in order to understand better their resource economics.
Methods: Four areas of 1 ha with different disturbance historic were sampled in the State Park of Serra do Mar in São Paulo State, Brazil. The traits analyzed were: maximal CO_2 assimilation rate (A), Respiration rate (R), instantaneous water use efficiency (WUEi), Leaf dry mass content (LDMC), Branch density (BD), leaf area to sapwood area (L:S) and leaf area (LA). We sampled tree individuals of all 55 species that composes seventy per cent of the total basal area of each plot.
Result: The PCA analysis for all 55 species shows that the first axe (40% of total variation) is composed by the leaf carbon economic spectrum and the second axes (27% of total variation) is composed by aspect of leaf and branch water economy, mainly WUEi in oposition to L:S and BD.
Discussion: The two main axes have orthogonality suggesting independence between the two groups of functional traits, e.g. strategies of carbon use are decoupled from strategies in the investment in vascular tissue and water use. Interestingly, only part of the total space available is occupied and restricted to intermediate values of carbon economy and investment in vascular tissue plus water use. This high diversity of strategies in the acquisition and use of carbon and water may be the result of the «stabilizing niche differences», where the complementary use of resources allows a greater number of species coexistence in the same area and produces an increased community resource use efficiency. For this to happen there must be the narrowing of the ecological niche of the species in question and therefore a decrease in interspecific variability and increased intraspecific variability as proposed by the theory of coexistence (Chesson 2000).

P40-02 – S40 *Tropical tree structure and function: directions and gaps four decades after Hallé*
17:30 – 18:30 – Joffre Area (Level 1)

Comparative study of architecture and geometry of the date palm male and female inflorescences.

OUMAROU ZANGO[1], CLAUDIO LITTARDI[2], RENÉ LECOUSTRE[3], HERVÉ REY[4]
[1]CIRAD, AMAP, 34398, Montpellier, France
[2]CRSP, Espaces Verts, 18038, San Remo, Italie
[3]CIRAD, AMAP, 34398, Montpellier, France
[4]CIRAD, AMAP, 34398, Montpellier, France

The date palm, Phoenix dactylifera L. (Arecaceae), is a subtropical palm widely cultivated for numerous uses and ecosystematic services. The date palm is a dioecious species, which shows a marked dimorphism in inflorescence structure. To describe this dimorphism, architecture and geometry of male and female inflorescences were studied through kinetics of inflorescencial development and architectural and geometrical characterization of mature inflorescences. Two methodological approaches were used: a visual approach consisting of direct observations of inflorescence architecture of trees in situ and a technical approach through the valuation of different structural and geometric parameters of inflorescence. On every plant, inflorescence development is acrotone. Every palm leaf axils an inflorescencial bud. Inflorescence and female spikelets are longer than male ones. For female inflorescence, spikelets lengths are linked to their relative position on the rachis, the number of spikelets is on average 62, every spikelet carries 55 flowers on average. For male inflorescence, the length of spikelets seems independent of their relative position on the rachis. Number of spikes and flowers is higher with on average 236 spikes per rachis and 81 flowers per spike. In conclusion, architecture of male spikelets is more complex than female one.

P42-01 – S42 *Developing research capacity on biodiversity and conservation: a caribbean challenge*
17:30 – 18:30 – Joffre Area (Level 1)

The International multidisciplinary thematic network Caraïbes: a joint-venture between CNRS-INEE and Caribaea Initiative for research excellence in the Caribbean Region

PIERRE-MICHEL FORGET[1], FRANK CÉZILLY[2,3]
[1]Muséum National d'Histoire Naturelle, UMR MECADEV CNRS-MNHN, 1 avenue du Petit Château, 91800 Brunoy, France
[2]Université de Bourgogne – Franche Comté, UMR CNRS 6282 Biogéosciences, Dijon, France
[3]Caribaea Initiative, La Tour du Valat, 13200 Arles, France

The prospectives Mer and Ecologie Tropicale of the Insitute Ecology and Environment (INEE) of the CNRS demonstrated that many researchers and professors in CNRS-INEE units were developing research in the Caribbean region, in both marine and terrestial ecosystems in various disciplines (ecology, evolution, environment, territory, human-environment interactions, etc.). The survey conducted in 2012 on the interest of INEE units in Tropical Ecology revealed that of 56 units developing research in the tropics, 25 did so in the Caribbean, mainly in French Overseas teritories such as Guadeloupe (15/25) and Martinique (16/25), but also in other foreign territories in the region. However, the dispersion of actors and themes between the different units and initiatives require greater scientific structure to bring together the skills and join forces for research excellence. Caribbean international multidisciplinary thematic network (Réseau Thématique Pluridisciplinaire International, RTPI) has thus been created by CNRS-INEE aiming at structuring scientific research around four key themes particularly developed in the Caribean region: 1) Biogeography and evolution; 2) Diversity and health ; 3) Human-ecosystem interaction; 4) Invasive species. A task force has been formed to promote and structure research in the Caribbean region with representatives of the involved laboratories and Caribbean colleagues, including ultra-marine departments and territories. This RTPI has four roles, ie to coordinate, facilitate, inform, and train students and researchers. Built initially around the CNRS units and university teams overseas and mainland involved in Caribbean region, it is now expanding to foreign partnerships with the collaboration and partnership of Caribaea Initiative.

P43-01 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

From biocontrol agent to successful invader: the harlequin ladybird (Harmonia axyridis) world expansion and its potential threats

MORELIA CAMACHO-CERVANTES[1], ADRIAN ORTEGA-ITURRIAGA[2], EK DEL-VAL[1]
[1]UNAM, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, México
[2]UNAM, Centro de Investigaciones en Geografía Ambiental, 58190, Morelia, México

Background: Invasive species cause an array of ecological, economic and health impacts in invaded ecosystems. Biocontrol agents use is a common way of introduction and dispersal of invaders. The Harlequin ladybird is a native Asian biocontrol agent that has established invasive populations in Europe and America. We aim to document the non-native range of this ladybird, origins of the introductions that have led to the current distribution and experts' insights on the subject.
Methods: We reviewed published articles containing the words "Harmonia axyridis", gathered information on the Harlequin ladybird's presence and represented it on a map. We also surveyed entomologists around the world (74 scientists from 31 countries) working with Coccinellidae to investigate insights about the current distribution and vectors of introduction, habitat use and threats this species pose. We build a second map with reports from these entomologists and report and discuss their perceptions about introduction and effects of the Harlequin ladybird in their countries.
Results: We found the Harlequin ladybird has established at least in 55 countries and it is reported absent in Australia, Cuba, New Zeeland and the Philippines. This ladybird arrived to the surveyed countries mainly as biocontrol and expanded its range afterwards. Nineteen scientists considered Harmonia axyridis a potential threat to native Coccinellidae. Published studies and scientists suggest that Adalia bipunctata, native to Europe, is under the highest risk of population declines.
Discussion: Harmonia axyridis is a generalist voracious predator that preys on different species including other ladybirds' eggs and larvae. It is considered a nuisance to humans because they bite and overwinter inside buildings. Harmonia axyridis has many if not all of the characteristics of a successful invasive species, given that it has already established in a wide variety of habitats and its able to tolerate an large range of environmental conditions we predict it could establish potentially anywhere.
Conclusion: Harmonia axyridis is considered a threat particularly to local Coccinellidae but also to arthropod´s biodiversity in general. Areas that are not invaded should incorporate strict policies to prevent its arrival. Places where Harmonia axyridis is already present should manage its populations to prevent further expansion range. Managing invasive species is key to prevent biodiversity loss and promote ecosystem services.

P43-02 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

The social dimension of restoration in seasonally dry tropical forests: a dialogue of knowledge with the indigenous NGO Xuajin Me'Phaa, in Guerrero, Mexico

CECCON ELIANE
Universidad Nacional Autónoma de México, centro regional de Investigaciones, Multidisciplinarias, calz. de tlalpan 2971 torre 7, 4650, Coyoacan, Mexico

The degradation of natural ecosystems services affects the whole society, however, rural communities are the most affected. Then, restoration strategies depend on the active participation of these social groups in a dialogue of knowledge. The region of La Montaña in Guerrero, has a high degradation level of vegetation and a very low level of health services, education and quality of life. In this region, the NGO Xuajin Me'Phaa, AC, was formalized in 2006 and is comprised of about 300 rural farmers. From them, 124 are active producers of organic Hibiscus sabdariffa flowers. In 2008, the Regional Center for Multidisciplinary Research (CRIM in Spanish) of the National Autonomous University of Mexico began working with this cooperative in many local and landscape restoration projects using the methodology of action-participation research. First, the percentage of land degradation and fragmentation of the region was assessed in three different altitudes and was described the reference ecosystem. A next step was to characterize organic production of hibiscus flower and the consumption of natural resources, mainly fuelwood and the most used species. Productive restoration experiments were also set to evaluate the potential to produce ecosystem services of some tree species. In 2013 the NGO obtained its own financing source to restore the cultural home gardens of 200 farmers. The action-participation research methodology associated with a high social capital among cooperative members were the main reason for the success of this restoration project.

P43-03 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Mediating factors shaping ecosystem services for people's resilience to climate variability in forest landscapes

GIACOMO FEDELE[1], HOURIA DJOUDI[2], BRUNO LOCATELLI[3]
[1]CIRAD, Ecosystem and Society, 34000, Montpellier, France
[2]CIFOR, Forests and Environment, 00000, Lima, Peru
[3]CIFOR, Forest and Livelihoods, 16115, Bogor, Indonesia
[4]AgroParisTech, ABIES, 75005, Paris, France

Changes in land use and management affect the capacity of ecosystems to deliver services that contribute to the well-being of societies and their resilience to climate variations. For example, forest ecosystems help regulating water flows during extreme rains depending on species characteristics (roots and leaves) and people's inputs and decisions (planting trees in specific areas) determined by governance and economic settings (land ownership and labour). The linkages between ecosystems services and people's resilience to climate variations are mostly studied indirectly and findings are scattered in the literature. In particular, the social-ecological systems interactions for resilience have often been described generically (as ecosystem services and land management), considered as unidirectional (flows of services from ecosystems to people), and neglected multiple aspects (ecosystems own sensitivity or role in livelihoods diversification).
The study aimed to identify mechanisms or mediating factors that enable or constrain the supply of ecosystem services to build people's resilience to climate variations. We reviewed the literature on forest ecosystems' contributions to increase rural people's resilience and proposed a framework that was applied to case studies in Indonesian communities affected by drought and floods. Forest ecosystem services and their benefits to local people were assessed through forest inventories, satellite images, focus group discussions, and household surveys.
People's response strategies to climate-related events partially relied on the benefits provided by forest ecosystems but surprisingly in less forested places there were more strategies based on trees. This difference between potential and actual use suggested that human inputs and other favourable conditions determine whether ecosystems service can effectively contribute to increase people's resilience. In fact, the provision of benefits was mediated by ecological and anthropogenic factors such as knowledge & skills, values & beliefs, access to services & markets, land tenure & use rights, technology & infrastructure, and social norms & networks. Therefore, functional ecological processes might need to be actively maintained, complemented or partially modified by human actions before becoming actual benefits. A better understanding of how ecosystem services contribute to people's resilience can support the design of more effective and sustainable land management practices.

P43-04 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Education and Outreach: Creating educational materials for children, in support of community-directed ecotourism and local conservation

OLUWATOBI OLANIYI, TOYIN KEKERE, BABAFEMI OGUNJEMITE
Federal University of Technology, Akure, Ecotourism and Wildlife Management, 23401, Akure, Nigeria

Young people living in villages in or near wildlands have the potential to be the conservationists of tomorrow, yet educational materials in local languages are few and far between. In this poster, I will discuss a number of strategies my group has employed for engaging Southeast Asian village children on conservation topics immediately relevant to their own communities. These materials include interpretive posters and pamphlets on jungle-dwelling wildlife, supported by photographs captured by remote cameras, and children's books featuring illustrations of and stories about creatures featured in remotely captured photographs and which are known by villagers to inhabit adjacent forests.

P43-05 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Socio-ecological resultants of human-nature interactions in a brazilian slam's reforestation, thirty years after its implementation

GABRIELA AKEMI ODA, MARIANA DE ANDRADE IGUATEMY, LUCAS BRASIL, ALINE MACHADO, RICHIERI SARTORI, ANDRÉ ZAÚ
Federal University of Rio de Janeiro State, Environmental Science, 22290240, Rio de Janeiro, Brazil

The Atlantic Forest cover's decrease, due to urban pression, led to instability of slopes, causing economic and social environmental losses. In order to reverse that scenario, the Rio de Janeiro's county created the «Mutirão de Reflorestamento» program in the 80's using local manpower and expressed an understanding of how a reforestation program must be done at that time. About 200 reforestation fronts and 2260 ha of planted area were deployed in thirty years of program. To ensure socio-enviromental integration and to monitor indicators of successional trajectories are necessary to the reforestation success. This study aimed to identify the socio-ecological resultants of human-nature interactions in the reforestation study area and it's possibilities to a future tropical ecosystem. Interviews were conducted with Formiga community's residents seeking past social environmental perceptions. 60 plots were sampled, where physical, structure and phytosociology were measured. It was carried out the phenological monitoring of the community and the collect of litter and seed bank in 47 of these plots. Differences were observed in the physical structure between the reforestation and the reference ecosystem. It were found 457 and 264 individuals in the tree and shrub layer respectively. In the seedling bank there was an increase of shrubs/trees. The seed bank was feasible, and is mainly formed of eudicotyledonous. Seed rain along with phenology's data showed a low ratio of fleshy fruits different from the one found in tropical forests (≈90%). Interviews indicated that the area had extensive vegetation which was gradually withdrawn for the residents' use and occupation. The use of local springs to supply the community appeared as a permanency of this slam's early years. Problems with fire and inadequate waste disposal are present and reach reforestation areas. All variables showed comparatively lower values in the reforestation area, when compared to the reference environment (diversity of trees and shrubs, leaf litter, seedling density). It is recommended enrichment with zoochoric species to attract wildlife and reduce the dominance of species. Environmental education programs based on the identity strengthening of the surrounding population are important to secure the reforestation success and the ecosystem services to the community.

P43-06 – S43 Free session: Human-nature interactions in tropical landscapes
17:30 – 18:30 – Joffre Area (Level 1)

Unintended multi-species co-benefits of community-based fluvial beach protection in lowland Amazonia

JOAO CAMPOS-SILVA[1], CARLOS PERES[2], JOSEPH HAWES[2], PAULO ANDRADE[3]
[1]Universidade Federal do Rio Grande do Norte, Ecology, 59078970, Natal, Brazil
[2]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK
[3]Universidade Federal do Amazonas, Produção Animal e Vegetal, 69077000, Manaus, Brazil

Tropical floodplains arguably represent the most threatened freshwater ecosystems worldwide, and various strategies have been proposed for their conservation. Despite the increasing threats from large dams, floodplain agriculture, overexploitation of aquatic resources and global climate change, these environments remain relatively neglected, particularly in the Amazon. Building a solid conservation programme to address floodplains system is therefore an intractable but pressing challenge. The protection of fluvial sand beaches, focusing on the conservation of South American river turtles, effectively represents a successful programme in reverting population trajectories for overexploited aquatic species. Furthermore, the effects of beach protection can have positive ripple effects for many other taxa that also use fluvial beaches and adjacent habitats. Here, we analysed 32 years of Giant South American Turtle (Podocnemis expansa) reproductive monitoring, through community-based beach protection, along the Juruá Rver of western Brazilian Amazonia. The number of protected beaches increased from 3 to 15 over this period, and the number of protected P. expansa nests increased seven-fold. We implemented a multi-taxa approach in evaluating 14 pairs of protected and unprotected beaches (N = 28) during the dry season of 2013. We sampled caimans, large catfish, other aquatic megafauna (with sonar), migratory beach-nesting birds, resident birds, lizards and invertebrates. We found a drastic effect of community based protection for all taxa sampled. Beach protection explained 70-85% of variation in abundance, even considering other key environmental variables (e.g. beach area, beach slope, sand type). Moreover, 99% of the P. expansa nests recorded on unprotected beaches were raided by poachers, compared to just 2% on protected beaches. We therefore show that Podocnemis expansa can act as a powerful umbrella species in protecting many other taxa, and that community-based fluvial beach protection is an efficient conservation strategy that merits greater attention from policy makers in Amazonian countries. However, this will require improving the socioeconomic condition of «beach-guards» who enforce protection at their own risk, to address the wide existing asymmetry between the ecological and social gains flowing from this program, and ensure long-term sustainability.

P43-07 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Institutionalisation of environmental movements: the case of protected areas in the Amazon

SANDRA NICOLLE, MAYA LEROY
AgroParisTech, GEEFT, 34090, Montpellier, France

Background: Protected areas represent management arrangements, whose aim is the protection of natural ecosystems in a specific geographic area. Today they are presented as the main public policy tool for environmental protection worldwide. These public policies for nature protection most often emerge thanks to the action of resisting actors.
The objective of this article is to show the relationships between the environmental actions taken by the resisting coalitions, and the protected areas that are finally implemented.
Methods: On the basis of a comparison between French and Brazilian territories in Amazonia, we analyse the creation of protected areas based on various management paradigms: strict preservation, indigenous territories and sustainable forest management. We work in environmental management sciences. The research methods are mainly based on semi-directed qualitative interviews (env 120 interviews), document analysis and direct observations.
Results and discussion: We show that the efficiency of the protected areas depends: (i) on the environmental "paradigms" of the resisting coalitions, and (ii) on the ability of these coalitions to modify the socio-political and institutional context in which they are embedded. We finally stress the importance of counter-powers for environmental matters to be taken into consideration in public policies.

P43-08 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Quantifying the host communities' dependence on Chimpanzees' habitat of Ise Forest Reserve, Southwest Nigeria

OLANIYI OLUWATOBI, KEKERE TOYIN, OGUNJEMITE BABAFEMI
Federal University of Technology, Akure, Ecotourism and Wildlife Management, 23401, Akure, Nigeria

Ise Forest Reserve had a high potential to be a good ecotourism attraction due to being adjudged a high priorities site for chimpanzees conservation in southwest Nigeria. Diversities of forest resources attracted the host communities to exploit the protected area as a means of livelihood. For this reason, the research was carried in order to determine the availability status of forest resources and forest products over time and socio-economic dependence of the host communities on Ise Forest Reserve, Ekiti State, Southwest Nigeria. The host communities were subjected to multistage sampling technique and direct household survey was conducted for primary data collection. The data were collected using questionnaire method and a total number of one hundred and thirty questionnaires were distributed to five selected communities namely: Ogbese- Ise, Obada, Afolu, Ago-Igbira and Ise- Ekiti. Forest Resources Availability Index was computed to determine the perception of host communities on availability status of forest resources and forest product over time. Result showed that the Forest Resources Availability Indices of the selected host communities were 0.61, 0.57, 0.61, 0.54 and 0.61 respectively, with a decreasing forest resources and forest products over the years. Forest dependency indices of the selected host communities were 58.84, 54.17, 61.64, 70.61 and 26.27 respectively. The Forest dependency of host communities on fodder, fuel and medicine were very high (except housing materials) with determining factors such as the agrarian nature of the community, type of inhabitants (indigenes or non-indigenes) and community's proximity to the reserve. However, there will be the need for relevant stakeholders such as governmental and non-governmental organizations to ensure formulation and prioritization of sustainable livelihood initiatives, provision of social incentives, initiation of systemic forest restoration program and organization of conservation education to the host communities.

P43-09 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Beyond the restoration ecology: social perspectives in Latin America and Caribbean

DANIEL PÉREZ[1], ELIANE CECCON[2]
[1]Universidad Nacional del Comahue, Facultad Ciencias del Ambiente y la Salud, 8300, Neuquén, Neuquén
[2]Universidad Nacional Autónoma de México, Centro Regional de Investigaciones Multidisciplinarias, 04640, Mexico, Mexico

From the organization of the Latin American and Caribbean Society of Ecological Restoration (SIACRE in Spanish), links among groups of researchers and practitioners in the region were established. One product of this network was a book regarding social aspects of ecological restoration in tropical forests, and other ecosystems. The main questions to organize the book were: Can we make the restoration exceed the limits of ecological basic research? How to achieve the participation of the rural communities in restoration projects? Can restoration bring a new relationship between society and nature? What the role plays legislation and politics? Is possible to set up a Latin American identity in ecological restoration?
There were many methodologies from social sciences and ecology. The compilation was organized from an initial reflection referring to the Latin American reality and philosophical debates as anthropocentrism and ecocentrism, nature, capital, among others. The cases are presented by country and conclusions were made.
There is an emergency of individuals or groups with different approaches, problems, limiting contexts and needs. The main social concepts of practice was «empowerment», «organization»; «awareness», «communities of practice», «participatory action research», «volunteer». Knowledge production was mediated by the discovery that occurred in the same implementation of projects and not hypothetical-deductive method. Participants were of broad social spectrum: government agencies, researchers, NGOs, farmers, volunteers and indigenous peoples among others.
An increasingly tangible identity of Latin American ecological restoration is displaying. It is appreciate the incorporation of concepts and methodologies of social sciences. Political and philosophical positions are also discussed.

P43-10 – S43 *Free session: Human-nature interactions in tropical landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Salar de Uyuni (Bolivia): fragile biodiversity challenged by tourism and agriculture expansion

ARTHUR SANGUET[1], ROSA I. MENESES[2], PHILIPPE CHOLER[3], FRANÇOIS MUNOZ[1], FABIEN ANTHELME[1]
[1]IRD, AMAP, 34398, Montpellier, France
[2]Herbario Nacional de Bolivia, Museo de Historia Natural, 99999, La Paz, Bolivie
[3]CNRS, LECA, 38000, Grenoble, France

There are no many places combining environmental stress like the Salar de Uyuni does. Located at 3660 m a.s.l. within the Bolivian tropics and reaching more than 150 km in length, it experiences not only extreme temperatures but also a very dry climate and extreme levels of salinity. Nevertheless, within this large salt matrix, the presence of more than 50 volcanic islands constitutes a refuge for an overlooked biodiversity adapted to extreme conditions. This system is an archipelago but its specific matrix makes it a challenging case to test the island theory of McArthur and Wilson. From a societal viewpoint, the Salar is an important place visited by tourists and constitutes a significant income in the region. The sandbeaches of the islands are also an interesting place for farmers to grow quinoa (Chenopodium quinoa). From an ethnobotanic perspective, the plants found in the islands are medicinal and food resources for the people living at the border of the Salar. Taking into account that the biodiversity of the islands is totally overlooked so far, we first described it as a list (approx. 100 species) in 52 islands and identified six habitats corresponding to six different plant communities, using 135 vegetation quadrats. Habitat variation seemed to be dependent on topography, elevation, exposition and salinity. As expected by the island theory, distance from the Salar border and the size of each island were the best predictor of plant species richness. Nevertheless, the island most visited by tourists (Incahuasi) was unusually species-poor in our model, indicting the probable negative effects of intense human disturbance. Islands were Quinoa was cultivated was more species-rich because of the additional presence of anthropogenic species. In comparison with the Salar border, a number of palatable species were more abundant in the islands, taking advantage of the absence of domestic herbivory. Finally, the highest islands (100-200 m) had a different species assemblage, which we interpreted as due to their older emergence (they were not flooded by lakes during the last 45000 years). In conclusion, the plant richness was higher than expected and was shown highly sensitive to changes in human activities. Its intraspecific value remains to be evaluated.

P44-01 – S44 *Free session: Secondary forest succession and restoration*
17:30 – 18:30 – Joffre Area (Level 1)

The role of resprouting on the long-term recovery of tropical dry forests along secondary succession

FRANCISCO MORA[1], JORGE A. MEAVE[1], JUAN M. DUPUY[2], PATRICIA BALVANERA[3], RADIKA BHASKAR[4], EDWIN LEBRIJA-TREJOS[5]
[1]Universidad Nacional Autónoma de México, Facultad de Ciencias, 04510, Mexico City, Mexico
[2]Centro de Investigación Científica de Yucatán A.C., Unidad de Recursos Naturales, 97200, Mérida, Mexico
[3]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, Mexico
[4]Haverford College, Department of Biology, 19041, Haverford, United States of America
[5]University of Haifa-Oranim, Faculty of Natural Sciences, 3600600, Oranim, Israel

Background: Resprouting has been proposed as a relevant mechanism for tropical dry forest (TDF) regeneration during secondary succession, speeding up forest structure recovery and convergence to old growth forest composition, thus contributing to the system's resilience. Although several studies have revealed a high incidence of resprouting plants during early succession (0-10 years), no studies have assessed the contribution of resprouts along the entire successional process. Our goal was to assess the role of resprouting on the long-term successional recovery of TDF from three Mexican regions, where secondary succession has been monitored during at least ten years in permanent plots that represent chronosequences.

Methods: We identified the origin of each plant (i.e. either seed or resprout) by careful inspection of their bases. Plants with cut or burnt stumps or multi-stemmed plants from species not usually multi-stemmed were defined as resprouts, while the rest were defined as seed-derived. We compared the absolute and relative contributions of each regeneration mechanism to plant density, biomass, species richness and species composition along succession. Moreover, we assessed the demographic drivers (mortality, recruitment, and growth) underlying such patterns.

Results: The contribution of resprouts to forest structure peaked early in succession (ca. 20 yr), when they accounted for 40 % and 60 % of the plants and biomass, respectively, declining steadily afterwards. In turn, the relative number of species established from resprouts declined steadily along time, while species composition in old secondary and old-growth forests was mostly accounted for by seed-derived species.

Discussion and conclusions: The observed patterns are explained mainly by the high recruitment of resprouts only in early succession and their high growth rates, along with the continuous recruitment and growth of seed-derived plants. Apparently, differences in the contribution of resprouts to forest recovery among sites could be related to the successional status of resprouting species, i.e. sites with higher representation of pioneer species in the resprouting group show a more restricted long-term contribution of resprouts to successional development. Our results have implications on the conceptualization of TDF recovery, for which a combination of the regeneration and persistence niche concepts would provide a more complete picture of the successional process.

P45-01 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

The effect of climate change on the functional composition of frugivorous bird communities along an Andean elevational gradient

IRENE MARIA ANTOINETTA BENDER[1], MATTHIAS SCHLEUNING[2], MATTHIAS DEHLING[3], ISABELL HENSEN[4], INGOLF KÜHN[5], THORSTEN WIEGAND[6], DANIEL KISSLING[7]
[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Flexible Pool, 04103, Leipzig, Germany
[2]Senckenberg, Biodiversity and Climate Research Centre, 60325, Frankfurt (Main), Germany
[3]University of Canterbury, School of Biological Sciences, 8140, Christchurch, New Zealand
[4]Martin-Luther-University Halle-Wittenberg, Institute of Biology, Geobotany and Botanical Garden, 06108, Halle, Germany
[5]Helmholtz Centre for Environmental Research (UFZ), 06120, Halle, Germany
[6]Helmholtz Centre for Environmental Research (UFZ), 04318, Leipzig, Germany
[7]University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics (IBED), 1090 GE, Amsterdam, the Netherlands

Climate change profoundly influences biodiversity. Changes in biodiversity are likely to trigger a disruption and a reshuffling of biotic interactions in ecological communities, potentially causing multiplicative effects of climate change on biodiversity and ecosystem functioning. Thus far, however, very little is known about the consequences of disrupted and reshuffled biotic interactions for tropical biodiversity and ecosystem functioning. A fundamental ecosystem function in tropical forests is animal-mediated seed dispersal and frugivorous birds are specifically important dispersers. This project aims to unravel the effects of climate change on the functional composition of frugivorous bird species along an elevational gradient in the Peruvian Andes. Successively, it can indicate how these changes affect the ecosystem function provided by these communities. We know the community composition of frugivorous birds on seven elevational belts on the gradient, ranging from 500 to 3500 m elevation. In addition, a database was compiled of trait data and GBIF occurrence data for 245 frugivorous bird species. We apply Species Distribution Models (SDMs) to derive climate envelopes for all bird species. Climate anomalies from IPCC climate models and emission scenarios will be used to derive the future climate on each elevational belt. We will compare the climate envelopes of the species with the future climate on the elevational range to obtain future frugivorous bird communities. For all current and future communities we will analyze the species richness, functional diversity and community weighted means of trait values. These metrics illustrate the service the avian frugivore community can lend to the ecosystem and, specifically, to the seed dispersal of fleshy-fruited plants. Finally, in order to assess the effect of climate change on the functional composition of the frugivorous bird community, all values will be compared between current communities and future communities for each elevational belt. Functional changes in various response variables can highlight community changes but also changes in the service the community can provide to the ecosystem.

P45-02 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Community patterns of wood density along an Andes-to-Amazon gradient

WILLIAM FARFAN-RIOS[1], MILES R. SILMAN[2], IMMA OLIVERAS[3], YADVINDER MALHI[3], ALEX NINA[4]
[1]Wake Forest University, Biology, 27106, NC, USA
[2]Wake Forest University, Biology - Center for Energy, Environment and Sustainability, 27106, NC, USA
[3]Oxford University, Environmental Change Institute, School of Geography and the Environment, OX1, Oxford, UK
[4]Oxford University, Environmental Change Institute, School of Geography and the Environment, OX1, Oxford, UK
[5]Universidad Nacional de San Antonio Abad del Cusco, Biology, CUZ, Cusco, Peru

Background: Major changes in forest diversity, plant species composition and functional diversity occur along environmental gradients, and the Andes-to-Amazon gradient is Earth's longest and highest biodiversity forest gradient. Wood density is an important functional trait related to wood properties and carbon accumulation. The few studies of this trait across altitudinal gradients have shown a decrease with increasing elevation, though this trend is still unclear in the tropics. We (1) tested the effects of elevation on interspecific variation and stand-level wood density across 3.5 km altitudinal gradient and (2) looked at the intraspecific variation across the gradient.
Methods: More than 891 tree core samples were taken for 314 taxa at 59 sites across a 3.5 km altitudinal transect running from Andean tree line to Amazonian lowlands in Peru. We used data from 16 1-ha permanents plots (ABERG network) across the gradient to test the effects of elevation in wood density weighted by number of individuals (NI) and basal area (BA).
Results: Results showed a positive relationship of wood density with elevation and this trend is even stronger when wood density was weighted by NI, BA. We observed an abrupt transition in wood density at ~1500 m in the cloud base zone. The intraspecific relationship between elevation and wood density differ greatly among species, with taxa showing increasing, decreasing, and no response to elevation.
Discussion and/or conclusion: Turnover in species composition had a direct effect on stand-level wood density and showed a strong relationship with elevation. These results for Andean and Amazonian systems have implications in forest biomass calculations and in general understanding of ecosystem function.

P45-03 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Are the floristic composition of montane forest changing within their woody layers? A study in the Kahuzi-Biega National Park (Democratic Republic of the Congo)

CIRIMWAMI LEGRAND[1], AMANI CHRISTIAN[2], GOURLET-FLEURY SYLVIE[3], KAHINDO JEAN-MARIE[4], DOUMENGE CHARLES[3], GONMADJE CHRISTELLE[5]
[1]Université du Cinquantenaire, Faculté de Sciences, Université de Kisangani, PO.Box. 2012, Kisangani, Kisangani, DR Congo
[2]CIFOR, CIFOR-RD Congo, Center for International Forestry Research; 25, av. Grevilleas, Goma, D.R.Congo, Goma, DR Congo
[3]CIRAD, UR B&SEF, Campus International de Baillarguet, TA-C-105/D, F-34398 cedex 5, Montpellier, France
[4]Université de Kisangani, Faculté des Sciences, Université de Kisangani, PO.Box. 2012, Kisangani, Kisangani, DR Congo
[5]University of Yaounde I, Plant Biology, University of Yaounde I PO BOX 812, Yaounde, Cameroun, Yaounde, Cameroun

The comparison between overstorey and understorey (woody layers) composition had been investigated in many studies without taking into account the altitude. Therefore, the impact of altitude on the variation of the floristic composition of the understorey vs overstorey remains poorly understood. We postulate here that the rate of overstorey species present in the understorey tends to increase with the altitude. The objective is to assess the dynamic trends of a forest in a case of altitude variation.
To investigate the variation of the floristic composition of the understorey and the overstorey of montane forests, we inventoried the highland forests (1800 to 3315m asl) of the Kahuzi-Biega National Park in the Democratic Republic of the Congo. Trees greater than 10 cm of diameter at breast height (dbh) were numbered and identified in 10 x 1ha plots (overstorey), in each of which we nested a 0.1ha (understorey, woody plant with dbh<10cm). We measured the altitude for each plot. Fisher alpha and rarefaction r were calculated. For each couple of plot, we calculated the percent of overstorey species which are present in the understorey to see if the overstorey species are well represented in the understorey.
In the two layers alpha and r decrease when the altitude increases. The overstorey species are well represented in the understorey varying from 47.37% to 76.92% and tend to increase with the altitude (coefficient of correlation = 0.34, p=0.34). At least, 23.08% of the overstorey species are absent in the understorey. Differently from the rate of overstorey species present in the understorey, some of the most abundant species in the overstorey are present but rare in the understorey albeit the most common species in the understorey are those which will likely incorporate later on the overstorey. This means that these species don't meet suitable conditions to regenerate or seldom regenerate beneath themselves. We found a likely future change in the floristic composition of the overstorey in these forests.
As already found in other studies, woody plant diversity decreases with increasing altitude. We found also that floristic elements of the understory that will likely integrate the canopy are often different from that of the current overstorey. This suggests future changes in the floristic composition of these montane forests if there are no major disturbance in the forest or if the mortality rate will not be greater among the abundant understorey species.

P45-04 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Biodiversity patterns of butterflies and moths (Lepidoptera) communities along a complete Afrotropical forest gradient

VINCENT MAICHER[1,2], SZABOLCS SÁFIÁN[1,3], TOMASZ PYRCZ[4], AXEL HAUSMANN[5], ŠTěPÁN JANEčEK[6,7], ROBERT TROPEK[2,6]
[1]University of South Bohemia, Faculty of Science, CZ-37005, České Budějovice, Czech Republic
[2]Biology Centre, Institute of Entomology, CZ-37005, České Budějovice, Czech Republic
[3]University of West Hungary, Institute of Silviculture and Forest Protection, H-9400, Sopron, Hungary
[4]Jagiellonian University, Zoological Museum, 30-060, Kraków, Poland
[5]Zoological State Collection Munich, Sektion Lepidoptera, 81247, Munich, Germany
[6]Charles University in Prague, Faculty of Science, CZ-12844, Prague, Czech Republic
[7]Czech Academy of Science, Institute of Botany, CZ-37982, Třeboň, Czech Republic

Background: Altitudinal gradients, as important models for explaining biodiversity changes with various environmental conditions, have been recently studied in many places around the world. However, in contrast with others tropical regions, Afrotropical rainforests still offer a substantial lack of comprehensive data. The highest mountain in West/Central Africa, Mt. Cameroon (4095 m a.s.l.), offers the only complete tropical forest gradient from seashore to timberline in the whole continent, as well as an important hotspot of biodiversity and endemism. Here, we present the first results of our intensive research of both butterfflies and moths along the complete altitudinal gradient of Mount Cameroon.
Method: We have been sampling butterflies and moths at 7 elevations equally covering the complete forest gradient. Focusing on both nocturnal and diurnal communities of Lepidoptera, we have applied two main methodological approaches. Fruit-feeding butterflies and moths were captured by 80 traps baited by fermented bananas per elevation covering both understorey and canopy layers (as much as we know, the most intensive bait-trapping worldwide, especially for moths). Simultaneously, we have sampled moths by standardized active light collecting. In the last three years, our sampling covered dry season, as well as both transition seasons.
Result: So far, more than 35,000 specimens were collected and are under process. The species richness of majority of the already processed groups is firstly growing with the altitude with a peak of diversity at about 300-700 m a.s.l. with a continuous decrease in higher elevations. Simultaneously, a high species turnover among the elevations was detected. On the other hand, both these patterns vary among the seasons.
Discussions: We bring the first study of a complete altitudinal gradient in the Afrotropical forests, together with the most intensive standardised bait trapping along an altitudinal gradient. Both altitude and seasonality show important effects on biodiversity patterns of butterflies and moths. Including of often avoided lowest elevations revealed interesting patterns of low biodiversity not observed in many other studies. Although we have detected an interesting shift of the biodiversity patterns with the seasons, the low species numbers at the lowest elevations are consistent.

P45-05 – S45 *Biodiversity patterns and processes along altitudinal gradients in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Cross-continental comparison of the functional composition and carbon allocation of two altitudinal forest transects in Ecuador and Rwanda

HANSVERBEECK[1], BAUTERS MARIJN[1], BRUNEEL STIJN[1], DEMOL MIRO[1], TAVEIRNE CYS[2], VAN DER HEYDEN DRIES[2], KEARSLEY ELIZABETH[1], CIZUNGU LANDRY[3], BOECKX PASCAL[2]
[1]Ghent University, CAVElab Computational and Apllied Vegetation Ecology, 9000, Gent, Belgium
[2]Ghent University, ISOFYS Isotope Bioscience Laboratory, 9000, Gent, Belgium
[3]Université Catholique de Bukavu, Faculty of Agronomy, BP285, Bukavu, DR Congo

Tropical forests are key actors in the global carbon cycle. Predicting future responses of these forests to global change is challenging, but important for global climate models. However, our current understanding of such responses is limited, due to the complexity of forest ecosystems and the slow dynamics that inherently form these systems. Our understanding of ecosystem ecology and functioning could greatly benefit from experimental setups including strong environmental gradients in the tropics, as found on altitudinal transects. We setup two such transects in both South-America and Central Africa, focussing on shifts in carbon allocation, forest structure, nutrient cycling and functional composition. The Ecuadorian transect has 16 plots (40 by 40 m) and ranges from 400 to 3000 m.a.s.l., and the Rwandan transect has 20 plots (40 by 40 m) from 1500 to 3000 m.a.s.l. All plots were inventoried and canopy, litter and soil were extensively sampled. By a cross-continental comparison of both transects, we will gain insight in how different or alike both tropical forests biomes are in their responses, and how universal the observed altitudinal adaption mechanisms are. This could provide us with vital information of the ecological responses of both biomes to future global change scenarios. Additionally, comparison of nutrient shifts allows us to compare the biogeochemical cycles of African and South-American tropical forests.

P46-01 – S46 *Free session: Climate change in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Limitation of reproductive success of a cavity nesting bird (Momotus mexicanus, Momotidae) during an ENSO event in Central Mexico

GRÉGORY MICHAËL CHARRE, MARCELA OSORIO BERISTAIN, OMAR PANIAGA
Universidad Autónoma del Estado de Morelos, Centro de Investigación en Biodiversidad y Conservación, 62209, Cuernavaca, Mexico

Soil texture, composition and orientation play another key-role for birds to achieve successfully their nestling period. We assessed the breeding success of the Russet-crowned Motmot (Momotus mexicanus) nesting along the earth bank on a secondary road corridor in a seasonally dry tropical forest in Central Mexico. We monitored 28 nests from construction to abandonment and characterized the composition of the soil in which they were constructed and other physical variables. We used a chi-square test to compare environmental values like precipitation amounts between seasons and soil composition between nests. We performed a pairwise non-parametric Mann-Whitney´s U-test on means for nest characteristics and nest orientation. Accumulated precipitation was 52.4% more intense in 2003 than the year before, with a significantly different distribution of the amounts recorded. Only one nest produced two fledglings, the others failed to breed successfully: 46 % of the nests experienced flooding or wall collapses while the nests built on sandy loam soil remained intact. Nest characteristics did not significantly differ between collapsed and undamaged tunnels, except for entrance diameter. The other nests that failed in reproductive success (54%) could be explained by inadequate soil properties like higher soil granulometry and penetrability or site exposure to depredation and inclement weather. The combined effect of elevated precipitations, high humidity and nest location in open site, as well as poor high quality available soil to construct nests probably impeded Motmots pursuing their nesting activities. This study could be of great interest for forest managers and help conserving suitable Motmot habitats with special focus on maintaining riparian corridors with substrate banks that permit the excavation of structurally stronger nest-cavities.

P46-02 – S46 *Free session: Climate change in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Life history and diurnal vs nocturnal activity determine the thermal tolerance in ants along elevational gradients

HÉCTOR CHUQUILLANQUI SOTO[1], CARLOS GARCÍA-ROBLEDO[2], ERIN KUPREWICZ[2], FEDERICO ESCOBAR-SARRIA[3]
[1]Universidad Nacional Mayor de San Marcos (UNMSM), Ecology and Terrestrial Biogeography Lab, Lima 01, Lima, Peru
[2]National Museum of Natural History (NMNH), Smithsonian Institution, 20013-7012, Washington D.C., USA
3Institute of Ecology (INECOL), Red de Ecoetología, 91070, Xalapa, Mexico

At a global scale, thermal tolerance of insects increases with latitude, but decrease with elevation. However, behavior and microhabitat conditions are also key factors that may shape insect thermal limits. Ants play an overwhelming role in ecosystem processes, they have a wide geographical distribution and display ecologically diverse traits. This makes them an ideal system to determine the role of time of activity (diurnal vs nocturnal) or microhabitat preferences on insect tolerance to high temperatures. Our objective was to compare changes of the critical thermal maximum (CTmax, defined as the temperature where insects lose righting response), in ant species with contrasting time of activity (diurnal vs nocturnal) and microhabitat use. Using a water bath connected to a thermostat, we estimated CTmax in ants by increasing temperatures at 1.5 °C/min. We estimated CTmax for 25 ant species across five sites in the south-eastern region of Mexico, from 0 to 1500 m.a.s.l. For each species, we recorded information about diurnal/nocturnal foraging activity and microclimate preferences (i.e., canopy, understory, litterfall and open areas). Differences in mean CTmax of ant species and communities across sites were explored using an analysis of covariance including locality, time of activity, microhabitat and ant subfamily as factors. We found a relationship between microclimate use and CTmax. Desert ants foraging on the ground displayed the highest CTmax. Litterfall ants in tropical lowland and montane forests displayed the lowest CTmax. Nocturnal ants usually display lower CTmax than diurnal ants. CTmax of ants in the warmer habitats (e.g., desert) were higher than in habitats with lower mean annual temperatures such as lowland and montane forests. Our results show the relevance of evaluating the variation in thermal tolerance at a local and microclimatic scale to improve predictions on the effects of global warming in ectothermic organisms, such as ant communities.

P46-03 – S46 *Free session: Climate change in tropical ecosystems*
DATE – 17:30 – 18:30 – Joffre Area (Level 1)

Functionality and adaptation of species of the genus Espeletia in paramo ecosystem in the eastern Colombian Andes - South America

OMARMELO[1], NATHALY RODRIGUEZ[2], CAROLINA MENDEZ[3]
[1]Universidad Del Tolima, Forestry Science, 73001, Ibague, Colombia
[2]Universidad Austral, Bosques Y Medio Ambiente, 5090000, Valdivia, Chile
[3]Universidad Del Tolima, Forestal, 73001, Ibague, Colombia

The study of functional of the species of the same genus provide insights into the strategies that allow the coexistence of closely related species and their adaptation to growth environment. We studied in situ functional traits and habitat variables related to the acquisition and use of resources in four species of Espeletia (ASTERACEAE) to assess whether the functional features change between and within species, and if there is a pattern related to adaptation to growth environment in an environmental gradient. The research was conducted in preserved areas of the Paramo de Guerrero, in the eastern Andes of Colombia. The average annual rainfall varies between 1100 and 1300 mm, the average temperature between 6 and 12° C. The altitude varies between 3000 and 3750 m. The study area covers 11,500 hectares with preserved vegetation. An altitudinal gradient corresponding to the edge of the paramo (3000 m), low paramo (3250 m), medium paramo (3500 m) and high paramo (3750 m) was located. 40 circular plots (100 square meter) were established at each site. We analyze the following functional traits: Total height of the plant, leaf life span, seed mass, nitrogen and phosphorus in the leaf, presence of hairs on the mature leaf, ratio root/shoot). we assess habitat variables: photosynthetically active radiation, slope, soil moisture, pH (acidity) and Carbon / Nitrogen factor. The principal component analysis (PCA) showed that the genus Espeletia have acquisitive tendencies. The functional characteristics of Espeletia cf. Congestiflora and Espeletia cf. Conglomerata showed a stronger acquisitive trend (higher values of specific leaf area and lower root/shoot ratio) while Espeletia cf. Argentea and Espeletia chocontana Cuatrec show a more adaptive trend (higher values of root shoot ratio and low specific leaf area). It was also found that the availability of water in the soil and slope are the most important variables in the partition of habitat for the genus Espeletia, which could best explain the mechanisms of coexistence of these four species and their functional and adaptive responses to changes in climate. These results will generate strategies for adaptation and conservation of these species to climate change for this strategic ecosystem of American Andes.

P46-04 – S46 *Free session: Climate change in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Arboreal ant community responses to seasonal flooding in an Amazonian white-water system

ELIZABETH PRINGLE[1], TALITHA FERREIRA DOS SANTOS[2], MARCELLE GONÇALVES[2], CARLOS PERES[3], FABRICIO BACCARO[2]
[1]Max Planck Institute for Chemical Ecology, Department of Biochemistry, 07745, Jena, Germany
[2]Universidade Federal do Amazonas, Department of Biology, 69077, Manaus, Brazil
[3]University of East Anglia, School of Environmental Sciences, NR4 7TJ, Norwich, UK

The structure and diversity of Amazonian faunal communities are strongly affected by forest hydrology. To determine how prolonged seasonal flooding governs the structure of arboreal ant communities, we compared ant assemblages between seasonally flooded várzea forests and adjacent, unflooded terra firme forests. Previous studies suggest that ant species richness is higher in terra firme than in várzea forests, in part because ants cannot nest year-round in várzea soils. Other metrics of ant communities remain mostly unstudied in these ecosystems.
We sampled seven pairs of várzea and adjacent terra firme forest sites along ~115 km of the Juruá river in western Brazilian Amazonia. At each site, ants were sampled along 100 m-long transects using ground pitfalls, litter samples, vegetation beating, and arboreal pitfalls during both the dry and inundation seasons (September 2014 and May 2015, respectively). Here we present the results from the arboreal samples (vegetation beating and arboreal pitfalls).
The abundance of worker ants was higher in arboreal samples from várzea than from terra firme forests. The direction of this difference was consistent regardless of sampling method or season, although the magnitude of the effect varied and was more evident in the dry season. In addition, preliminary analysis of morphospecies richness suggested that alpha diversity was higher in arboreal assemblages in várzea than in terra firme forests. This result depended on sampling method but again was consistent between seasons. Our results contrast with the few reports available comparing ant assemblages between floodplain and terra firme forests. Although patterns based on morphospecies are still preliminary, the higher abundance of arboreal ants in várzea than in terra firme forests is quite striking and is a metric that has rarely been considered in comparisons between the two forest types. We hypothesize that these trends are reversed for ground-dwelling ants (i.e. higher ant abundance and diversity in terra firme than in várzea), which suggests an interesting dichotomy between vertical strata in the ant assemblages of these two forest types. We speculate that several mechanisms could drive the higher abundance and diversity of arboreal ant assemblages in várzea forests, including levels of disturbance, light, seasonality, and nutrient availability.

P47-01 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
17:30 – 18:30 – Joffre Area (Level 1)

Synthesis of the different uses of Miconia spp from Brazilian cerrado: from traditional uses to conservation and restoration practices

DURAND-BESSART CLÉMENTINE[1], MENDOZA IRENE[2]
[1]AgroparisTech, Master_BioGET, 34090, Montpellier, France
[2]UNESP, Departamento de Botânica, 13506-900, Rio Claro (SP), Brazil

Background: Brazilian cerrado is the most diverse savannah in the world, but its conservation is greatly threatened by different land use changes derived from human activities. This astounding diversity of species is not only ecologically relevant but also affects human wealth and health. The Melastomataceae, which include the genus Miconia are dominant species in secondary plant succession and they are particularly abundant in the Brazilian cerrado. Like many plant species, their conservation is threatened by the intensive fragmentation of this biome all over Brazil.
This work reviews the role of Miconia spp. in ecological restoration. It also evaluates the traditional uses for local human communities of the species, as well as their potential for medical research. Thank to this, we aim to define environmental conservation strategies for these species and also to allow the preservation of traditional cultural knowledge.
Results: Miconia spp are so abundant and widespread in the Brazilian cerrado that some studies defined them as essential in conservation processes of the savannah. This outlines the role of Miconia spp as a keystone and pioneer species, thanks to their large production of fruits that attract many frugivorous animals, mostly birds, and their efficient germination.
These species are also used in traditional medicine. For instance, M. albicans is used against inflammations such as arthrosis, eupeptic problems as well as rheumatism and other bone and articular pains and M. rubiginosa has analgesic properties. Their properties are also recognized in pharmacology, some studies having demonstrated their antibacterial, antioxidant and antiinflammatory effects. Other uses include domestic cleaning or firewood.
Discussion and/or conclusion: Miconia spp. are essential to the ecosystem balance of the Brazilian cerrado. A conservation program on Miconia spp. would allow to protect many other species of plants and animals that depend on them, and help in restoration plans of this particularly endangered Brazilian savannah. Including local communities in the conservation program will allow raising awareness about safeguarding their environment, and will also enable the saving of some ancestral medicinal practices and local botanical knowledge.

P47-02 – S47 *Tropical grassy biomes. Part 1. Grassland ecology, conservation and restoration*
17:30 – 18:30 – Joffre Area (Level 1)

The neotropical Gran Sabana region: palaeoecology and conservation

VALENTÍ RULL[1], TERESA TERESA VEGAS-VILARRÚBIA[2], ENCARNI MONTOYA[1]
[1]Institute of Earth Sciences Jaume Almera (ICTJA-CSIC), Environmental Geology and Geohazards, 08202, Barcelona, Spain
[2]University of Barcelona, Ecology, 08202, Barcelona, Spain

The Gran Sabana (GS) is a key region for understanding the origin of neotropical savannas and is an ideal location to test ecological hypotheses on long-term vegetation dynamics under the action of natural and anthropogenic drivers. The conservation of the GS is a controversial issue because of the confluence of disparate cultural and socio-economic interests, with a strong debate surrounding fire practices by indigenous people. Late glacial to Holocene pollen and charcoal records obtained thus far in this region have documented the main palaeoecological trends along with the climatic and anthropogenic (mostly fire) drivers involved. Here we discuss how these records can be used to inform conservation and restoration practices in the GS. The main points of the discussion are the local vs. regional character of palaeoecological evidence, the support provided by this evidence for the existing fire management proposals and the role of spatiotemporal environmental and ecological heterogeneity in the definition and evaluation of realistic restoration targets. A general conclusion is that past ecological reconstructions do not fully support either of the current options for fire management, i.e., either total fire suppression or the continuity of indigenous fire practices. It is recommended to replace this dual and rigid conservation framework with a more diverse and flexible approach that considers the complex spatiotemporal heterogeneity documented in palaeoecological records.

P48-01 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

Microwave soil heating for controlling invasive plant species germination

MÉLISSA DE WILDE[1], MANON HESS[2], ELISE BUISSON[1], FRANÇOIS MESLEARD[1,2]
[1]Université d'Avignon, IMBE, CNRS, IRD, Aix Marseille Université, IUT d'Avignon, 84911, Avignon, France
[2]Centre de Recherche de la Tour du Valat, Le Sambuc, 13200, Arles, France

Background: Several methods of invasive plant eradication are available (manual and mechanical control like plant uprooting, shredding, burning and mowing; chemical control like herbicide use; or biological and ecological controls) but examples of successful long-term eradications are rare. This can be partly explained by the fact that the eradication methods target only the adult stage and does not take into account the development capacities from a very important propagules bank. New methods thus have to be implemented.
Method: Microwave radiation causes dielectric heating of moist material and enables reaching rapidly temperature needed for loss of seed viability (60-80°C range). We tested the effect of different combination of powers (2, 4, 6kW) and durations (2, 4, 8 min) on 3 target invasive plant species (Fallopia japonica, Datura stramonium, Solidago gigantea). We also evaluated the effect of soil humidity (10, 20, 30%) and seed depth (2 cm, 12 cm) on the efficacy of the microwave treatment on germination capacity.
Results: The most efficient treatments were: 2kW8min, 4kW4min, 6kW2min and 6kW4min (4kW8min and 6kW8min were not tested for technical reasons), but did not allow to eradicate all seeds. Their efficiency decreased with increasing soil humidity. In some cases, efficiency also decreased with depth. Solidago gigantea was the most sensitive species, probably due to the small size of its seeds.
Conclusion: These first results are encouraging and experiments are on-going to determine the characteristics of the microwave that will be used in the field.

P48-02 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

The fate of tropical forest soil carbon in a warmer world

ANDREW NOTTINGHAM, BENJAMIN TURNER, JEANETTE WHITAKER, NICK OSTLE, NIALL MCNAMARA, RICHARD BARDGETT, NORMA SALINAS, ADAN CCAHUANA, MICHAEL ZIMMERMAN, YADVINDER MALHI, PATRICK MEIR
[1]University of Edinburgh, School of Geosciences, EH8 9XP, Edinburgh, UK
[2]Smithsonian Tropical Research Institute, -, 0843-03092, panama, Panama
[3]Centre for Ecology and Hydrology, Lancaster Environment Centre, LA1 4AP, Lancaster, UK
[4]Lancaster University, Lancaster Environment Centre, LA1 4YQ, Lancaster, UK
[5]The University of Manchester, Faculty of Life Sciences, M13 9PT, Manchester, UK
[6]Seccion Química, Universidad La Católica, lima, Peru
[7]Universidad Nacional de San Antonio Abad del Cusco, Facultad de Biología, Cusco, Peru
[8]University of Natural Resources and Applied Life Sciences, University of Natural Resources and Applied Life Sciences, 821190, Vienna, Austria
[9]Environmental Change Institute, School of Geography and the Environment, OX1 3QY, Oxford, UK
[10]Research School of Biology, Australian National University, ACT 0200, Canberra, Australia

Climate warming predicted for the tropics in the coming century will result in average temperatures under which no closed canopy forest exists today. There is, therefore, great uncertainty associated with the direction and magnitude of feedbacks between tropical forests and our future climate. This uncertainty is vital to resolve if we are to understand the fate of the third of global soil carbon contained in tropical forests.
Here we describe the potential climate feedbacks that may arise through warming in tropical forests by drawing on findings from studies of a 3.5 km elevation gradient – and 20oC mean annual temperature gradient - in the Peruvian Andes.
These studies have revealed the manner in which interacting chemical, biological and physical factors may influence the soil carbon balance under future warming. Chemical factors determined the decomposition of plant organic matter, including litter quality (carbon to nutrient ratios) and chemical composition of carbon compounds (lignin vs. cellulose). Soil microbial communities determined respiration rates during decomposition and plant community composition shifts were associated with changes in and quality and quantity of litter inputs to soil. However, the longer-term response of carbon loss to warming was strongly determined by the physical structure of soil aggregates.
Natural temperature gradients, such as this Peruvian elevation gradient, are powerful tools to investigate ecosystem responses to temperature, but require supporting experimental investigation. Finally, we describe a new soil warming experiment being undertaken in in Panama, the first of its kind in tropical forest, designed to improve our understanding of biogeochemical feedbacks to climate warming.

P48-03 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

Long term decomposition processes and soil fauna community changes along an altitudinal gradient in a tropical montane rainforest in southern Ecuador

FRANCA MARIAN, DOROTHEE SANDMANN, VALENTYNA KRASHEVSKA, MARK MARAUN, STEFAN SCHEU
Universtiy Goettingen, J.F. Blumenbach Institute of Zoology, 37073, Goettingen, Germany

Decomposition is one of the most important processes in terrestrial ecosystems. Especially in tropical montane rainforests, which harbour large stocks of dead organic material, little is known about the factors driving decomposition processes. We investigated the effect of altitude, litter origin and litter type on long term decomposition rates, microorganisms and soil microarthropods in a tropical montane rainforest in southern Ecuador. Leaf litter from three abundant tree species and roots of different diameters were collected from three sites along an altitudinal gradient (1000, 2000, 3000 m). Litter and roots were placed in litterbags at the three altitudes, and after 6, 12, 24, 36 and 48 months the remaining amount of C and N, and microbial parameters as well as microarthropod abundance and oribatid mite community structure were determined.
Altitude and time were the main factors driving the investigated parameters, while origin and therefore quality of the litter material was of minor importance. At 2000 and 3000 m the amount of C declined over the first 12 months, before reaching a limit value of ~50% of initial, while at 1000 m decomposition continued after 12 months. This suggests that after 12 months lignified litter components accumulate at higher altitudes causing the thick layer of dead organic material. In contrast, at 1000 m favourable conditions for litter decomposition prevent the accumulation of soil organic matter. Site specific conditions also strongly affected microbial parameters, which followed a pattern similar to the decomposition rate. At the higher altitudes a decrease in microbial biomass after 24 months indicates a shift in the microbial community, while at 1000 m microbial biomass remained rather constant. Soil microarthropod abundance and oribatid mite diversity also decreased after 24 months indicating that they are closely related to decomposition rates and microbial community or driven by the same regulatory forces.
The results suggest that the thick layer of organic material at higher altitudes inhibits positive interactions between the microbial community in the upper litter layer and the mineral soil, causing the microbial and microarthropod community to largely depend on root derived resources. This indicates close trophic linkage between plant roots and the decomposer community especially at higher elevations.

P48-04 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

Effects of long-term litter manipulation on fine root dynamics in a Panamanian lowland forest

CHADTIP RODTASSANA, EDMUND TANNER
University of Cambridge, Department of Plant Sciences, CB2 3EA, Cambridge, United Kingdom

Litter manipulation changed nutrient and organic matter input in the forests mainly by changing litterfall quantity. Fine roots (less than 2mm diameter) respond sensitively to changing environment and have a rapid turnover especially in tropical forests. We predicted that root mass and production should increase in infertile condition from litter removal, whereas litter addition should cause a decrease. To investigate the effects of changing litterfall input, a long-term litter manipulation experiment was started in 2003 in lowland tropical forest in Panama. The initial measurements after 18 months of litter manipulation showed that root biomass was only lower in litter additions (05 cm depth). After ten years of long-term litter manipulation, we used various techniques to confirm the patterns of fine root dynamics including biomass (12-month soil cores), length (12-month rhizotrons), production (3-month interval ingrowth cores and 12-month rhizotrons) and survivorship (12-month rhizotrons). The results showed that fine roots had a strong seasonal pattern in lowland tropical forest. Contrast to a general prediction, my study showed only lower fine root biomass (0-5 cm depth) in litter removals in both wet and dry seasons. Fine root length patterns in litter removals and additions were different compared to the controls. Fine root production and fine root length survivorship from the same cohorts was not different in all litter treatments (0-10 cm depth). However, fine root length survivorship was approximately 40% after the first month of observation, which showed a high rate of root turnover. The results indicate that the long-term litter manipulation altered the patterns of fine root dynamics in lowland tropical forest via changing root fates (survivorship) and morphological responses (root length).

P48-05 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

Flooding and differences in soil composition determine beta-diversity and biomass stocks of lowland forests in Northern South America

PABLO R. STEVENSON, SASHA CÁRDENAS, PABLO J. NEGRET, ANA MARÍA ALDANA
Universidad de Los Andes, Ciencias Biologicas, 111711, Bogotá, Colombia

There is debate on which is the most determinant process in species turnover in tropical forests. Many studies have shown the relevance of abiotic factors explaining a significant part of the variation in plant species composition. However, it is also common to find a negative relationship between floristic similarity and distance, suggesting that dispersal limitation and random processes also affect the composition of plant assemblages. In this study, we used a set of vegetation plots designed to separate the effect of distance on abiotic variables (i.e. sampling both terra firme and flooded forest in each study site), to assess the relative effect of ecological factors and geographical distance. We used a set of 32 1-ha plots in three different basins in Colombia (Amazon, Orinoco and Magdalena rivers), where we registered and identified all woody plants (DBH>10 cm). We collected soil samples (in 25 plots), flooding frequency from a map based on radar technology, and assigned climatic variables to each site from Worldclim. A non-parametric ordination showed clear differences in floristic composition between terra firme and flooded forests, as well as distinctions between Varzea and Igapo. A canonical analysis showed that the first axis of the ordination was associated with soil variables (i.e. clay, carbon and nitrogen) and highly associated with flooding frequency. The second axis was associated with temperature and soil pH. An analysis of variance partitioning showed that almost 30% of the variation in floristic composition was attributed to ecological factors alone, while the variation explained solely by distance was less than 10%. Furthermore, the variation explained by both environment and geographical distance was also low (less than half of that explained by abiotic factors). We conclude that when there is an effort to separate the potential effect of distance on ecological similarity, environmental factors stand out as the main predictors in floristic composition in the lowland forests of Northern South America.

P48-06 – S48 *Free session: Ecology and conservation of tropical soils*
17:30 – 18:30 – Joffre Area (Level 1)

Investigating agricultural management practices and their impacts on soil microbial communities in Rarotonga, Cook Islands

OLIVIA WATKINS, KRISTA MCGUIRE
Barnard College, Biology Department, 10027, New York, USA

Due to the important role of microscopic life in driving nutrient cycling and decomposition of the soil, determining the affect of management practices on the microbial life in agroecosystems is important for healthy soil and fertile plants. The geographical focus of this study is on the tropical ecosystem of Rarotonga, one of 15 of the Cook Islands located in the South Pacific. We will use phospholipid fatty acid analysis, DNA sequencing, and nutrient analysis to comprehensively study the microbial communities of 3 organic farms and 3 conventional farms. Conventional farms, which use artificial fertilizers could have a significantly higher presence of nutrients N, P, and K than the organic farms but could be lacking other important macro and micronutrients essential for long-term survival. Using artificially made fertilizers decreases soil quality and depletes nutrients and minerals from the soil. The microbial life of the organic farms could be significantly more abundant than the microbial life of the conventional farms. In addition, there could be a significantly higher presence of bacterial microbes on the conventional farms than on the organic farms. Artificial fertilizers could create an imbalance in the belowground systems by creating an anaerobic environment, which could allow bacteria to thrive and outcompete fungi. As a result, the crops could have an increased chance of exposure to bacterial plant pathogens. Organic management can to be a more sustainable agricultural management method with respect to maintaining microbial abundance, diversity and overall health of the agroecosystem.

P52-02 – S52 *Free Session: Tropical ecology*
14.30-17.30 - Barthez – Joffre Area (Level 1)

Structure and diversity of urban forests in Malang city, Indonesia: a study of tropical urban forest sustainability

MUKHLISH JAMAL MUSA HOLLE[1], AHMAD ILHAM TANZIL[2], DAHLIA DAHLIA[3]
[1]Hokkaido University, Graduate School of Environmental Science, 060-0810, Sapporo, Japan
[2]Brawijaya University, Faculty of Agriculture, 65145, Malang, Indonesia
[3]State University of Malang, Faculty of Mathematics and Natural Science, 65145, Malang, Indonesia

Urban forest has critical roles for environment sustainability, such as regulating air and water quality, cooling down the air temperature, protecting from the ultraviolet radiation, maintaining biodiversity, reducing pollution, and keeping human health. However, existing together with human being in the urbanized city, urban forest existence is getting critically threatened. Moreover, studies of urban forest in tropical cities are left behind comparing to those in the temperate zone. Tropical country such as Indonesia is also facing rapid urbanization where Malang city is one of the rapid developed cities in Indonesia. Within city, there are 11 urban forests and Malabar forest (M), Jalan Jakarta forest (J), and Vellodrome forest (V) are three forests with the highest number of tree individuals and largest forests size. Because of its ecological roles and high urbanization rate in Malang City, it is important to maintain the sustainability of tropical urban forest by assessing its structure and diversity.
Forest structure and diversity were determined by calculating distribution and abundance of seedlings, saplings, and trees using Point Centered-Quarter Method (PCQM) in forest M, J and V. By assessing tree growth stages, the future urban forest could be predicted and how the current threat changes the forest structure also could be understood. After recording vegetation data from 41 plots, relative importance value (RIV) and Similarity Index Sorensen (SI) among plant developmental stages were calculated. Correlation between environmental factors and basal area was also analyzed using General Linear Model (GLM) in R.
Results showed that forest M has highest biodiversity with 22, 23, and 20 species for tree, sapling, and seedling respectively and sapling with highest density that dominated the forest. In the future, forest biodiversity in Malang city might decrease and stands may be dominated by Mimusops elengi (RIV: 21.80%), Swietenia macrophyla (RIV: 37.83%), and Spathodea campanulata (RIV: 30.33%) for forest M, J and V respectively.
However, the biodiversity decreased over developmental stages from tree to seedling and over time since forests have been established. Forest M relatively be able to keep its biodiversity sustain because of the higher soil moisture that can support plant establishment. Planting seedling and maintaining favorable environment are necessary for sustaining tropical urban forests in Malang city.

P52-03 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

The aftermath of hurricanes: new insights from American crocodile populations in Mexican Caribbean islands

PIERRE CHARRUAU[1], DIDIER LABARRE[2], STÉFANIE LAROCQUE-DESROCHES[2], JOSÉ ALBERTO GALLARDO CRUZ[1]
[1]Centro del Cambio Global y la Sustentabilida den el Sureste A.C, Funcionamiento de ecosistemas y conservación de la biodiversidad, 86080, Villahermosa, Mexico
[2]Faculté des Sciences, Université de Sherbrooke, Département de Biologie, J1K 2R1, Sherbrooke, Canada

Recent models suggest that anthropogenic-related global warming will lead to an increase in the number of major hurricanes. Tropical cyclones have strong effects on ecosystems which may modify animal populations' characteristics. However, very few data are available to analyze the effects of hurricanes on animal populations. The goal of this study was therefore to assess the body condition of American crocodiles (Crocodylus acutus) of Cozumel and Banco Chinchorro islands in Yucatan Peninsula and use it as a tool in order to better understand short- and long-term effects of hurricanes. The body condition of 392 crocodiles captured from 2003 to 2015 was assessed using Fulton's K. Crocodiles' body condition was analyzed in response to hurricanes throughout different environmental factors. Differences among populations, sexes, size classes and the variation occurring within a year were evaluated in order to identify implications of the increasing number of major hurricanes. American crocodile's body condition of Cozumel and Banco Chinchorro is generally good which suggests that these populations and their ecosystems are healthy. However, C. acutus is sensitive to salinity, temperature, tropical cyclones and reproductive events. The main result reveals that the tropical cyclones have a two-fold effect in the populations. In the short-term, the crocodile's health is negatively impacted; whereas in the long-term, the species seems to improve and maintain its body condition.

P52-04 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Human-Elephant Relations in Peninsular Malaysia: From Conflict to Coexistence

TECKWYN LIM
University of Nottingham Malaysia Campus, School of Geography, 43500, Semenyih, Malaysia

Human-elephant interactions in Peninsular Malaysia are shaped by an ecology that has evolved since the arrival of modern humans about 50,000 years ago. As sympatric megafauna, the symbiotic relationship between humans and elephants is complex and involves elements of predation, competition, commensalism and even a degree of mutualism. This relationship has undergone a rapid change in the last 100 years with the expansion of industrial plantations. However, Asian elephants stand out as an exceptional case of megafauna that has escaped extinction from hunting or habitat loss. This stands in contrast to many other large animals that are no longer found on the peninsula such as hippopotamus, Asiatic black bear, orangutan and rhinoceros. One factor influencing the survival of elephants is that some traditional communities (particularly the Orang Asli) consider elephants to be «taboo species». I carried out a series of semi-structured interviews with members of several Orang Asli groups to examine how such attitudes towards elephants and other wildlife are shifting in line with the move from subsistence to a cash-based economy.

P52-05 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

eDNA metabarcoding versus traditional methods for anuran surveys in the highly biodiverse Brazilian Atlantic Forest

MARTINS LOPES CARLA

Explanation of research being conducted: The persistence of species on the planet is currently threatened with the impact of introduced species, diseases, pollution/contamination, climate change, and fragmentation and degradation of habitats. Some organisms, such as amphibians, are more sensitive and consequently more negatively affected by anthropogenic environmental degradation. Brazil has the highest know diversity of amphibians, with nearly a thousand of described species. More detailed studies are required to understand the role played by the different factors that are threatening Brazilian amphibian species and to plan proper strategies for conservation action. This research project is divided in two parts. First, we report on a project using water samples collected in four streams located in an Atlantic Forest region where the anuran species are broadly known. The aim is to validate the eDNA metabarcoding methodology for a tropical environment to identify the presence of amphibian species in the field. Traditional methods of survey, like visual detection and calling survey were also conducted to compare the power of species detection of both methodologies. The eDNA methodology validated will be applied in a second project, aiming to detect endangered or declining amphibian species in the field. We will search for 22 species, distributed at 6 sites in the Brazilian Atlantic Forest, which are facing problems of conservation, e.g. severe declines in their population densities or species that disappeared from localities where they were previously know.
Stage of progress of work: Field sampling, laboratory procedures, and the analyses of results related to the validation of the eDNA methodology have been concluded, and we are currently analyzing the samples for detection of disappeared and declining species. I request funding to present these results at the ATBC 2016 meeting.
Budget of expenses for coming to this conference and other sought sources of funds: It will be necessary around €750 to cover flight tickets from Brazil to Montpellier, and ~ €250 to cover living costs in Montpellier. The CNPq/Brazil - National Counsel of Technological and Scientific Development will cover the early registration fee for the meeting (€300)
name of Advisor: Célio F. B. Haddad

P52-06 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Topography is shaping the structure of understory bird assemblages in Costa Rican lowland rain forests

CHRISTIAN H. SCHULZE, BERNHARD PACES, TOBIAS SCHERNHAMMER
University of Vienna, Division of Tropical Ecology and Biodiversity Research, Department of Botany and Biodiversity Research, 1030, Vienna, Austria

Background: Topography creates environmental gradients on continental, regional and local scales thereby shaping spatial patterns of biodiversity. On a local scale a wide range of abiotic variables such as water availability, soil composition and fertility, and microclimate, all affecting vegetation structure and composition, are changing along the gradient from hill tops via slopes to valleys. In this study we analyzed how bird assemblages are affected by such small-scale topographical landscape heterogeneity in a Pacific lowland rainforest area situated on a hilly terrain.
Methods: Our study area was part of the Esquinas Rainforest in the Pacific lowlands of south-western Costa Rica. Understorey bird communities were sampled over three different seasons (wet season: July/August 2014; end of wet season: November 2015; dry season: February 2015) by mist-netting at five different creek and ridge forest sites, respectively. To avoid pseudoreplication due to recaptures, all trapped birds were individually marked with colour rings. Only in hummingbirds we clipped the tips of the outer tail feathers to recognize individuals already mist-netted before.
Results: In total 849 birds belonging to 79 different species were caught. While species richness did not differ significantly between ridge and creek forest sites, both forest types were characterized by a distinct species assemblage composition. Furthermore, we found a distinct feeding guild composition in the two sampled forest types, e.g. the relative abundance of hummingbirds proved to be significantly higher at ridge forest sites.
Discussion: Our results emphasize, that topography is shaping species assemblages and feeding guild structure of mobile organisms such as birds even on small spatial scales. Hence, biodiversity assessments and conservation measures have to consider locally occurring topographic gradients in order to obtain representative data and develop efficient conservation measures, respectively.

P52-07 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Seasonal variation in tree growth along a hidro-edaphic gradient of oligotrophic forest in northern amazonia

CAROLINA CASTILHO1, JOSÉ JÚLIO TOLEDO[2]
[1]Embrapa Solos, UEP Recife, 51020240, Recife, Brazil
[2]Universidade Federal do Amapá, Programa de Pós-graduação em Biodiversidade Tropical, 68902280, Macapá, Brazil

Background: Understanding growth patterns of trees is essential to assess the potential of forests to accumulate carbon. Biotic and abiotic factors that influence tree growth vary spatially and temporally within forests. The goal of this study was to determine how abiotic factors (soil texture, water table depth and rainfall) influence the seasonal changes in tree diameter growth in a hidro-edaphic gradient of oligotrophic forest in northern Amazonia.
Methods: We analyze seasonal changes in tree diameter increment over three consecutive years (quaterly measurements between February 2013 to February 2016) among 2427 randomly selected individuals (dbh greater then or equal to 10 cm) of 290 forest tree species spread over 10 1-ha plots. The plots were located at the Viruá National Park (Caracaraí, Roraima, Brazil). The Virua network forest plot is a long-term research site coordinated by the Brazilian Biodiversity Research Program (PPBio). Intra-annual diametric growth was measured with plastic band digital dendrometers and calipers that are accurate up to ± 0.01 mm.
Results: We observed a strong seasonal variation in tree growth between sites and years and the overall tendency to reduce tree growth during the dry season followed by peaks of diameter increment during the rainy season. The plot mean annual growth vary from 0.1 to 2.3 mm/year. In plots located in sandy soils with shallow water table, the mean annual growth did not exceed 0.6 mm/year while in well-drained soils the mean annual growth could attain 2.3 mm/year. In the monitored interval, less than 40% of the individuals presented any growth suggesting that few individuals could be responsible for most of the forest net primary productivity.
Discussion: These observations will provide valuable insights into environmental and ecological triggers of diametric growth, differences in species sensitivity to these triggers, and potential limitations of forest productivity in response to climate change. The ongoing monitoring will also reveal the effects of 2015-2016 El Niño drought on tree growth and mortality in this still neglected area of Amazonia.

P52-08 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Landscape connectivity of the Mangroves forest in Costa Rica, Central America: one of the world's most threatened ecosystems

TANIA CHAVARRIA PIZARRO[1], ROXANA PIZARRO[2], ROBERT FLECTHER[3]
[1]University of Florida, Biology, 32611, Gainesville, USA
[2]Ministry of Environment, Geography, Nicoya, Costa Rica
[3]University of Florida, Wildlife managment and Conservation, 32611, Gainesville, USA

Mangrove forests occur along ocean coastlines throughout the tropics, and support numerous ecosystem services, including fisheries production and nutrient cycling, in addition, mangroves sequester approximately 22.8 million metric tons of carbon each year, and account for 11% of the total input of terrestrial carbon into the ocean. However, the areal extent of mangrove forests has declined by 30–50% over the past half century as a result of coastal development, aquaculture expansion and over-harvesting. Particular areas of geographical concern include the Atlantic and Pacific coasts of Central America, where as many as 40% of mangroves species present are threatened with extinction. In this fragmented landscape, the connectivity between habitat patches is very important to maintain viable populations. In this study, we aim to quantify connectivity of the Mangroves forest in Costa Rica, using graph theory to identify how landscape connectivity has change in the past 60 yeas, in order to establish conservation priorities and to direct conservation efforts. Graph theory is a good approach because connectivity indices combine spatially habitat data with species-specific dispersal data and can quantify structural and functional connectivity over the landscapes. We will use these indices to quantify the overall connectivity of the study area, to determine the change in connectivity. Natural areas were identified using 2008 land cover data for Costa Rica and compared with the first edition topographical maps that range between 1945 and 1965. Functional connectivity will be analyzed using the dispersal distances of Mangrove warblers (Setophaga petechia xanthotera) (5km), which is and endemic subspecies to the Mangroves forest in Costa Rica and is the focus species in my PhD research. Currently I am working on the analyses but the results are going to be ready for the ATBC 2016bsymposium.

P52-09 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Public policies, environmental conflicts and deforestation in the Cerrado of Southeastern Brazil
Do Espírito-Santo Mario

P52-10 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Factors are controlling beta diversity and local contribution to beta diversity in Amazon: a multi-taxa analytical approach
VICTOR LEMES LANDEIRO, BARBARAH FRANZ DE SOUZA
Universidade Federal de Mato Grosso, Programa de Pós Graduação em Ecologia e Conservação da Biodiversidade, 78060900, Cuiabá, Brazil

Several studies analyze patterns in beta diversity throughout the world and environments. The body of these studies on beta diversity, techniques, taxonomic groups and ecosystems have greatly increased in past few years. However, most developments were based in a single or few taxa analyzed separately.
Here we used public data that were made available by the research program on biodiversity (PPBio – ppbio.inpa.gov.br) in which we analyzed a series of 14 taxonomic groups (plants and animals) sampled in a regular grid of 9x8 km with plots spaced by 1 km, totaling 72 sampling sites. We calculated the local contribution to beta diversity (LCBD) for every sampling site (72 sites). Then, we constructed a response matrix composed by the LCDB calculated for each group and analyzed this matrix using a partial-RDA analytical approach. An environmental matrix and a spatial matrix (PCNM) were used as predictor variables of sampling site contribution to beta diversity. The turnover process is the main cause of beta diversity in this Region of the Amazon. The environmental conditions were the main factors governing the beta diversity, mainly phosphorus content and soil clay content. In general, the greatest local singularity (sites with higher LCBD) were those with lower species richness. This multitaxonomic approach had consistent results with studies that analyzed each data separately, and those groups most related to LCDB were those most related to P content.
Our results are consistent with those studies showing that productivity (P content) is one of the main factors maintaining beta diversity. This analytical approach might be very helpful to understand factors controlling several taxonomic groups, providing more data and foundations for future decision makers aiming to conserve nature.

P52Part 2-10 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

'FG Tree Key', a multi-access electronic key to identify Amazonian tree genera in French Guiana
JULIEN ENGEL[1], LOUISE BROUSSEAU[2], CHRISTOPHER BARALOTO[3]
[1]CNRS, UMR AMAP/EcoFoG, 34398/97310, Montpellier/Kourou, France/French Guiana
[2]INRA, UMR EcoFoG, 97310, Kourou, French Guiana
[3]ICTB, Florida International University, Department of Biological Sciences, 33199, Miami, FL, USA

Background: The tropical rainforest of Amazonia is one of the most species-rich ecosystems on earth, with about 16000 tree species estimated. Due to this high diversity, the identification of Amazonian trees is difficult, and may be achieved by specialists only. The democratization of informatics tools offers a promising opportunity to develop user-friendly electronic keys to help tropical trees identification.
Methods: French Guiana is a French department of 85000 km² located in the North-East of the Amazonian basin and it is covered by forests at 90%. Here, we introduce an original multi-access electronic key for the identification of tree genera encountered in French Guiana. The key was developed using the software Xper² and is implemented with a genera-character matrix. The database is publicly available on figshare.
Results: The key includes all dicots angiosperm genera occurring in French Guiana Terra-firme forests. A total of 389 genera belonging to 84 families are described based on 79 morphological characters related to vegetative, floral and fruits characteristics. They are grouped into 5 main sections: 'leaves', 'other vegetative characters', 'inflorescence', 'flowers structure', and 'fruits and seeds' (with a majority of characters related to leaves and thus easily observable). All genera and characters are defined and illustrated by photographs of herbarium samples and/or schemes.
Discussion/Conclusion: This identification key was developed to help the inventory of forest biodiversity in Amazonia by non-specialists, but also as a teaching tool to diffuse botanical knowledge. It is the unique electronic tool for the identification of trees in French Guiana. It allows the identification of tree genera with a reduced number of characters. In particular, the key is enriched in easily-observable (vegetative) characters (more common than fertile ones) which facilitate the identification. Moreover, its multi-access feature is not constrained by a hierarchical organization of characters commonly imposed by traditional dichotomous keys. Because the great majority of tree genera encountered in French Guiana are also present in other regions of Amazonia, this key may also be used and easily extended to other regions such as Brazil, Suriname, Guyana, or Venezuela.

P52-11 – S52 *Free Session: Tropical ecology*
17:30 – 18:30 – Joffre Area (Level 1)

Isotopic niche of small terrestrial mammals from a neotropical savanna (Cerrado)

JULIANA RIBEIRO, ANDRÉ GUARALDO, GABRIELA NARDOTO, GUILHERME SANTORO, EMERSON VIEIRA
Instituto de Ciências Biológicas, Universidade de Brasília, Departamento de Ecologia, 70919-970, Bras[ilia, Brazil

Background: Knowing the niche dimensions of the species that occur in a given location or region allows us to understand the mechanisms responsible for their co-existence. Because non-volant small mammals (i.e., marsupials and rodents) of the Central Brazilian savanna (Cerrado) are abundant and widely distributed throughout the biome, this is a particularly interesting group in which to evaluate the role of trophic niche partitioning in species co-existence.
Method: Using stable isotope ratios (δ13C and δ15N) and metrics of the isotopic niche, we evaluated dietary habits for 22 small mammal species from the Cerrado in two periods of the year (dry and rainy seasons) and in three of main types of vegetation formations that occur in the biome (grassland, savanna, and forest). In addition, we evaluated the dietary contributions of food items from three groups (C3 fruits, C4 grasses, and invertebrates).
Result: Most species of small mammals were found to be omnivorous, but the rodents Oecomys bicolor, Rhipidomys macrurus, and Nectomys squamipes tended to be more frugivorous, whereas the marsupials Monodelphis domestica and Gracilinanus agilis, together with the rodents Thrichomys apereoides and Oxymycterus delator, tended to be more insectivorous. The rodents Calomys tener, Calomys expulsus, Necromys lasiurus, Euryoryzomys lamia, Cerradomys scotti, Oligoryzomys nigripes, Oligoryzomys fornesi, Nectomys squamipes, Thrichomys apereoides, and Clyomys laticeps showed some dietary plasticity depending on the season and vegetation formation.
Discussion and/or conclusion: In addition, some species tended to increase the amplitude of the trophic niche in more complex areas compared to less complex areas, as in the rainy season compared to the dry season. These results indicate that the availability and diversity of food as well as habitat complexity influence food preferences and consequently the isotope assimilation of species.

P54-01 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Exploring the charcoal-food-water nexus with computer simulations: useful tools or mindgames?

ADRIAN GHILARDI[1,2], TUYENI MWAMPAMBA[3], JOSÉ LUIS CABALLERO[1], ROB BAILIS[4], ALBERTO GOMEZ-TAGLE[5]
[1]Universidad Nacional Autónoma de México, Centro de Investigaciones en Geografía Ambiental, 58190, Morelia, Mexico
[2]Universidad Nacional Autónoma de México, Laboratorio Nacional de Análisis y Síntesis Ecológica, Escuela Nacional de Estudios Superiores campus Morelia, 58190, Morelia, Mexico
[3]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, Mexico
[4]Stockholm Environment Institute, US Center, 02144-1224, Somerville, United States
[5]Universidad Michoacana de San Nicolás de Hidalgo, Instituto de Investigaciones sobre los Recursos Naturales, 58330, Morelia, Mexico

Computer simulations have been used widely in environmental sciences for decades. However, their usefulness as decision making tools depends on how well models perform against some «observed» reality. In the case of forest and woodland exploitation for charcoal making, however, the impact of management practices on woody biomass stocks, the water cycle and suitability of land for food production can be difficult to observe so as to validate models' simulations. In this work we explore the main challenges for developing computer models that are useful for decision making at management level. We will present a pair of landscape models developed for Mexico and Tanzania that will be used to address these challenges quantitatively. We will conclude by presenting a first draft on good-practice guidance and uncertainty management for the design, calibration and validation of computer models aimed at exploring the charcoal-food-water nexus, and ultimately inform about best land management alternatives.

P54-02 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

A land management and planning tool to support decision making for sustainable biomass extraction for charcoal production in Miombo forests with multiple use values

JOSE LUIS CABALLERO[1], ADRIÁN GHILARDI[1], ADRIÁN GHILARDI[2], TUYENI MWAMPAMBA[3], THERON BROWN[4]
[1]National Autonomous University of Mexico, Centre for Research in Environmental Geography, 58190, Morelia, México
[2]National Autonomous University of Mexico, Laboratorio Nacional de Análisis y Síntesis Ecológica, Escuela Nacional de Estudios Superiores campus Morelia, 58190, Morelia, México
[3]National Autonomous University of Mexico, Institute for Ecosystems and Sustainability Research, 58190, Morelia, México
[4]Tanzania Forest Conservation Group, TFCG, 58190, Dar es Salaam, Tanzania

More than 80% of urban and peri-urban household in Tanzania use charcoal produced from natural Miombo forests as their primary cooking energy, raising questions about the sustainability of production given high urbanization rates and limited forest resources. Studies since the 80s have highlighted the unsustainable exploitation of forests and woodlands around cities in Tanzania, yet attributing all degradation to charcoal production is complex because forests are also cleared for agriculture and timber extraction and degraded by grazing activities. National and international initiatives to reduce forest-related greenhouse gas emissions in the tropics have facilitated the development of integrated strategies that can maintain resource productivity in the long run. Yet, no specific tool exists for land managers to apply that allows them to systematically consider multiple land use activities, their biophysical and social interrelations, and the implications of external forces when planning and developing management strategies. Taking the Kilosa Sustainable Charcoal Project in Tanzania as a case study, we developed a landscape level simulation model that integrates spatial and temporal relations between charcoal production, agriculture and livestock to generate different management scenarios with distinct outcomes for each land use. Although still a work in progress, the ultimate goal is to build a decision making tool that is informed by locally generated data and which can be used by local land managers (such village councils) to explore alternative scenarios that take into consideration uncertainty bounds. Rather than identifying the «correct» management strategy, the model's main strength will be to help avoid strategies that could render undesired outputs in the long-run. By developing the scenarios and models together with land managers, it is hoped that the tool will address real issues that managers face in planning for multiple objectives by exposing key social and biophysical constraints intrinsic of the system.

P54-03 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Livestock effects on plant diversity in a neotropical montane oak forest managed for charcoal production: Are these compatible or conflicting land uses?

LUIS ALFONSO CASTILLO-HERNÁNDEZ, TUYENI H MWAMPAMBA
1National Autonomous University of Mexico, Institute for Ecosystems and Sustainability Research, 58190, Morelia, Mexico

Due to their hardwood properties, oaks are a preferred species for firewood and charcoal production virtually everywhere that they occur and they are often managed for multiple activities that co-occur with charcoal production, including livestock keeping, hunting and collection of non-woody forest products. Little is known about the effects of these human activities on diversity and regeneration of oak forests. In the highlands of western Mexico, the combination of these activities and the interactions between them have shaped present ecological and cultural landscapes. We studied the effects of excluding livestock on plant diversity and biomass, focusing on plants with medicinal and other use-values. Nine 10 x10 m plots were excluded from grazing for a period of 3 - 12 months immediately after harvesting for charcoal production. Herbaceous diversity, abundance, and biomass were monitored at 3-month intervals and compared to nine control plots.
Preliminary results indicate that grazing is changing floristic composition and herbaceous biomass. While species richness and diversity are not substantially different between treatment and control sites, species types and their dominances are. Additionally, exclusion plots have greater herbaceous biomass ($p < 0.05$). Species richness of plants with use value was higher in exclusion plots, indicating that there may be tradeoff between livestock keeping and managing for medicinal plants.
The implications of high biomass in the exclusion plots is controversial – while it benefits collectors of medicinal plants, it increases the risk of wildfires. Varying stakeholder preferences for different ecosystem services is clearly at play in this socioecological system. Our study highlights that livestock keepers' and charcoal producers' preference override those of plant collectors. To understand the interactions between grazing and charcoal production, more analyses are being undertaken to determine the nutritional value of forage in treatment versus control plots and how grazing affects oak regeneration.

P54-04 – S54 *Applying the nexus approach to understand tradeoffs and synergies between charcoal, food and water production in tropical forests*
17:30 – 18:30 – Joffre Area (Level 1)

Aboveground biomass estimation using aerial photography in subtropical managed oak forests

DIANA RAMIREZ-MEJIA[1], ALBERTO GOMEZ-TAGLE[2], ADRIAN GHILARDI[3]
[1]Universidad Nacional Autónoma de Mexico, Laboratorio Nacional de Análisis y Síntesis Ecológica, Escuela Nacional de Estudios Superiores campus Morelia, 58190, Morelia, Mexico
[2]Universidad Michoacana de San Nicolás de Hidalgo, Instituto de Investigaciones sobre los Recursos Naturales, 58330, Morelia, Mexico
[3]Universidad Nacional Autónoma de México, Centro de Investigaciones en Geografía Ambiental, 58190, Morelia, Mexico

Mexican oak forests (genus Quercus) are frequently used for traditional charcoal production. To ensure its long-term use while conserving the ecosystem services and benefits they provide, appropriate management programs should be implemented. A key variable needed to design these programs is the spatial distribution of standing timber volumes. The aim of this study is to develope a cost-effective methodology for the estimation of total aboveground biomass (AGB) and woody aboveground biomass suitable for charcoal making (WSC) in intensively managed oak forests, using as main input crown area measurements extracted from small format high resolution aerial photographs. This work was carried out at Cuitzeo basin, in central Mexico. To calibrate the method, we obtained tree field measurements of the diameter at breast height (DBH), crown diameter and the georeference of 204 sprouting oak trees. Using the coordinates of each tree and aerial photographs (30 cm resolution), we derive the crown area and generated linear regression models to test the allometric relationships between: a) field-measured crown area (CAf) and basal area (BA, derived from DBH), and photo-measured crown area (CAap) and BA. The results for the calibration site showed a highly significant linear relationship between the basal area and the crown area measured in both field and aerial photos. Based on these results, we selected 11 sites used for charcoal production at the Cuitzeo basin, and obtained DBH field measurements of 1604 sprouts (366 oak trees). To estimate AGB and WSC, we used specific allometric equations, expressed as a function of DBH, generated for sprouting oak trees subjected to traditional fuelwood harvesting. Field-measured DBH values (stems=1604) served as input to obtain the biomass estimates. We then established allometric relationships between: a) CAap and AGB, and b) CAap and WSC. We obtained a high significance level for the relationship between: a) CAap and AGB, and b) CAap and WSC ($R2=0.87$, $p < 0.0001$). The approach we used in the study showed that it is possible to obtain sound biomass estimates as a function of the crown area derived from aerial photographs. A next step is to apply this method to other areas subjected to: 1) different management practices and different biophysical conditions, and 2) to construct chronosequences to estimate oak sprouting productivity.

P58-01 – S58 *Monitoring and mapping tropical biodiversity and ecosystem services with remote sensing*
17:30 – 18:30 – Joffre Area (Level 1)

Comparative approach of optical radar remote sensing for monitoring forest cover, similarities and complementarities. Examples in humid tropical environment and in particular in the Congo Basin; Cameroon, DRC ....

JEAN-PAUL RUDANT[1], AYMÉ KEMAVO[2], BRUNO MUYAYA[3], BERNARD RIERA[4]
[1]UPEM, Matis/IGN, 77454, Marne-la-Vallée, France
[2]UPEM, ONFI, 75012, Paris, France
[3]ERAIFT, Eraift, BP 15373, Kinshasa, Democratic Republic of Congo
[4]CNRS, UMR 7179, 91800, Brunoy, France

Title: Comparative approach of optical radar remote sensing for monitoring forest cover, similarities and complementarities. Examples in humid tropical environment and in particular in the Congo Basin; Cameroon, DRC ....
Background: To monitor the forest cover, spatials tools as remote sensing by optical or radar offer a good approach particulary with new sensors developp during the late decae. Combined approach is also an interesting method to analyse forest cover in tropical countries where the rainy saison is in some cases an inconvinient.
Methods: We present a review of availability of free and open space remote sensing images, optical and radar for monitor the forest cover in tropical region. We have choosen examples of using images on multiple sites in the Congo Basin (Cameroon and Democratic Republic of Congo): (i) Region Douala with Mangrove forests and forest analyse with SPOT optical images (Sentinel 2), radar images (ERS, PALSAR, Sentinel 1), (ii) Southeast Region, near Kribi, a Forest of Planning Unit (FMU) optical images (Spot 6 galaxy), Images RADAR (Palsar, Sentinel 1), (iii) Region West Coast, around the estuary of the River Congo Mangrove Marine Park, optical images (Landsat 8, SPOT 5 and SPOT 7), Images RADAR (ASAR, ERS, PALSAR) and (iv) Region Kinshasa, Bombo Lumene Reserve (Savanna and forest) with optical images (Landsat 8, SPOT 5), Images RADAR PALSAR.
Results: We present an overview of the general properties of optical and radar images: physical, parameters concerning the surface and wave used influencing measures (including the effect of terrain), automatic extraction of information tools and image viewing modes. We realise for the four sites studied in the Congo Bassin a map of the ecosystem observed. We analyse the benefit and the contribution of each sensor to do the forest classification.
Discussion, conclusion: Based on the four examples we analyse the contribution of each sensor to observed and mapped the dffrent types of vegetation.
Illustrations in various areas demonstrating that optical and radar images are complementary, not contradictory.

P59-01 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
17:30 – 18:30 – Joffre Area (Level 1)

Kilimanjaro forest landscapes assessed from LiDAR point clouds: is there bias in field studies of forest structure?

STEPHAN GETZIN, RICO FISCHER, ANDREAS HUTH
Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modelling, 04318, Leipzig, Germany

Field inventory plots which usually have small sizes of around one hectare can only represent a fraction of the much larger surrounding forest landscape. The small size of such plots is the consequence of a trade-off between very detailed and still feasible quantities of data collection and often the chosen location of setting up a plot is affected by topographical constraints and local accessibility. These constraints may particularly affect the selection of inventory plots on tall mountains such as the Kilimanjaro in Tanzania because this ancient volcano has considerable slopes and also numerous steep gorges and valleys. Based on light detection and ranging (LiDAR) data it has been shown for tropical forests that the bias in the selection of small inventory plots may severely hamper extrapolation of structural forest attributes to landscape and regional scales. For example, mean biases in forest canopy structure (height, gaps, and layers) and aboveground biomass in both lowland Amazonian and montane Andean landscapes may reach as much as 9-98% (Marvin et al. 2014). Such biases may cause difficulties especially when the goal is to assess and simulate carbon stocks and fluxes with computer models for larger scales (Fischer et al. 2015).
We therefore conduct here a LiDAR study on tropical montane forest in equatorial East Africa and evaluate the representativeness of chosen inventory plots with respect to key structural attributes such as top-of-canopy height, standard deviation and coefficient of variation of height, gap fraction, and standing biomass. We show that these attributes may considerably differ between LiDAR measures derived from landscape grid plots and small inventory field plots. These results will be discussed with respect to topographical constraints and also potential anthropogenic influences.
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Fischer R, Ensslin A, Rutten G, Fischer M, Schellenberger Costa D, Kleyer M, Hemp A, Paulick S, & Huth A. (2015). Simulating carbon stocks and fluxes of an African tropical montane forest with an individual-based forest model. PLoS ONE 10: e0123300.

P59-02 – S59 *Mapping and monitoring tropical forest degradation with remote sensing*
17:30 – 18:30 – Joffre Area (Level 1)

A typology of forest degradation un the eastern amazon using remote sensing

CLÉMENT BOURGOIN[1], LILIAN BLANC[2], NICOLAS BAGHDADI[3], JOHAN OSZWALD[4], PLINIO SIST[2], VALERY GOND[2]
[1]CIAT, Agriculture, 10000, Hanoï, Vietnam
[2]CIRAD, ES, 34398, Montpellier, France
[3]IRSTEA, TETIS, 34000, Montpellier, France
[4]Université Rennes 2, LTEG, 35000, Rennes, France

The Amazonian pioneer front region is a mosaic of different forests types and agricultural landscapes resulting from the colonization of the region through forest conversion into pasture and agricultural lands. Fearnside and Guimaraes (1996) showed that 47% of the deforested area is rapidly abandoned. It also appears that logged forests surface is equivalent to deforested areas (Asner et al., 2005). Consequently a degradation gradient exists from low-impacted logged forests (depending of the logging intensity) to young secondary (regrowth) forests. To obtain more accurate estimation of carbon stocks, it is important today to take into account the degraded forest gradient including all degraded forest stages between mature intact forests and non-forest areas. The first main challenge is to identify and to characterize the various stages.
The identification of forest degradation is still a complex and expansive problem even if it has been focused until now only on logged tropical rainforest (Asner, 2009; Gond and Guitet, 2009; Desclées et al., 2006; Asner et al., 2005; Souza et al., 2003). In parallel estimation of biomass loss in the degraded forest is little-studied. Within temperate and boreal forests some estimation are made by Solberg et al., (2013). The combination of optical remotely sensed data (Landsat-8), radar (Terra-Sar-X) and Lidar (IceSat) have to be studied to analyze the potential of the multi-sensors techniques to characterize the tropical rainforest degradation (Betbeder et al., 2014).
The study presents the first results obtained during the field work at Paragominas (Pará, Brazil) on different forest degradation intensities (Bérenguer et al., 2014). This field database is then compared with multi-sensors remote sensing to better understand multiple interactions and to establish a forest degradation typology.

P60-01 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Ecological optimization on the use of native timber species on tropical degraded agricultural lands

CAROLINA MAYORAL[1], JEFFERSON HALL[1], MICHIEL VAN BREUGEL[2]
[1]Smithsonian Tropical Research Institute, AGUA SALUD project, Panama Ciudad, Republica de Panama
[2]Yale NUS College and National University of Singapore, Department of Biological Sciences, Singapore, Singapore

Background: Deforestation of tropical forests for uses such as agriculture and livestock has been a common practice in Panama for decades. More recently, a combination of increasingly low farm production and job opportunities in the city has left many farms fallow. The management plan of the Panama Canal watershed promotes reforestation to enhance social benefits. Indeed, a study published in 2003 predicted that much of the agricultural land eastern of the Panama Canal would be reforested by 2020. However, as of 2016 few of these areas have been reforested due to the fact that the preferred timber species, Tectona grandis (Teak), grows poorly on the infertile and clay soils that dominate. We report here on the growth of valuable native timber species in monocultures and mixtures in the Agua Salud native species project plantations.
Our objective was to find adaptive management strategies to maximize the ecosystem services from degraded land in the tropics by comparing the performance of native species in monocultures and mixtures. We also focused on the effect of edaphic factors on the variability in growth across plantations.
Method: 267 plots were set up in 2008 within the frame of the Agua Salud site, using 5 native timber species (Anacardium excelsium, Dalbergia retusa, Pachira quinata, Tabebuia rosea and Terminalia amazonia) that were planted in both monocultures and mixtures. We have used allometric tree biomass regression models to determine aboveground biomass (AGB) on each of the 21 different treatments established in order to identify differences between combinations of species.
Result: Terminalia amazonia had higher AGB (19.8±6.4 t/ha) at 6 years post planting than the other native species in monocultures. In the opposite end Tabebuia rosea had 5.0±3.9 t/ha. An interesting behavior was found in Terminalia amazonia but not in other species when growing in mixtures, exhibiting much higher AGB (38.8±15.7 t/ha) than in monocultures.
Conclusions: Multi-species plantations enhance growth of some species and improve the ecosystem functions. Furthermore, in the case of Terminalia amazonia, we found the strongest competitive advantage which is probably achieved because of the greater growing space than that existing when growing in mono-cultures where Terminalia amazonia trees are already competing.

P60-02 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Growth and survival of native tree species planted on an abandoned pasture in humid tropical lowland of Costa Rica

SVENJA KLEINSCHMIDT[1], ANTON WEISSENHOFER[2], DANIEL JENKING AGUILERA[3], PETER HIETZ[1]
[1]University of Natural Resources and Life Sciences, Vienna, Institute of Botany, 1180, Vienna, Austria
[2]University of Vienna, Division of Tropical Ecology and Animal Biodiversity, 1030, Vienna, Austria
[3]Tropical Field Station La Gamba, 178, Golfito/Puntarenas, Costa Rica

Biodiversity and functional diversity are important for growth, biomass accumulation, nutrient dynamics and the carbon sequestration potential of tropical forests. Even if there are many well-studied reforestation projects in the tropics, most of them are limited to few species. To examine the effects of biodiversity and functional diversity we planted more than 100 native tree species on an abandoned pasture close to La Gamba Biological Station in the humid tropical lowland of Costa Rica. Tree species were assigned to three different functional groups: low wood density (< 0.5 g/cm³), high wood density (> 0.5 g/cm³) and legumes. These functional groups were planted in all seven possible combinations, each with eight replicates in plots of 6 x 6 trees. To evaluate the performance of tree species and combinations thereof, we measured tree height, diameter and survival in 2013, 2015 and 2016. In addition we examined the change in canopy cover and the effects of shading by neighbouring trees on initial growth and survival. First results indicate considerable differences among tree species. As expected species naturally growing in secondary forests had higher initial growth rates than primary forests species. In addition, species combinations differed in the speed of carbon sequestration. To be able to give recommendations on appropriate tree selection and management (e.g. to increase the amount of carbon sequestered) and to understand the importance of functional diversity for ecosystem processes, we plan to follow stand development and ecosystem functions of the established experiment.

P60-03 – S60 *Management impacts on biodiversity and carbon/nutrient balances in the tropics*
17:30 – 18:30 – Joffre Area (Level 1)

Are grasslands green?

KARABI PATHAK[1,2], ARUN JYOTI NATH[2], YADVINDER MALHI[1], ASHESH KUMAR DAS[2]
[1]Environmental Change Institue, School of Geography and the Environment, University of Oxford, PX1 3QY, UK
[2]Department of Ecology and Environment Science, Assam University, Silchar 78811 India

Background: Soil Organic Carbon storage is an important global C sink. The *Imperata* grasslands of the tropical region are a vast underutilized natural resource. The objective of the present study is to describe the C source/sink status of customary managed grasslands of Imperata cylindrica var. latifolia (variety I) and *Imperata cylindrica* var. major (variety II) which are among the oldest forms of rural land use in Barak valley, North East India.
Method: Randomly soil samples from 0 to 25 cm soil depth were collected to analyze SOC and bulk density at monthly intervals. Soil C concentrations were determined by Walkley and Black's wet oxidation method. SOC stocks were calculated by multiplying the C content (%) by the bulk density and the thickness of the soil horizon (A).
C input to the soil from surface litter (B) and C input from necromass (C) were studied using standard method. Soil respirations, (D) were made at monthly intervals using the alkali absorption method of CO2 by soda lime.
Soil carbon budget (source/sink status) = (A + B + C) – D.
Result: SOC ranged from 17.9 g/m2/month to 22.4 g/m^2/month and 23 g/m^2/month to 25.8 g/m^2/month in variety I and variety II respectively. Carbon inputs to the soil from necromass and surface litter were the highest in August. Further soil respiration was estimated the lowest in December in variety and in January in variety II and soil systems in both varieties act as carbon source during February-June whereas it sink 76.5 gC/m^2 and 77.6 gC/m^2 during rest of the year.
Discussion and conclusion: Variety II proclaimed the higher SOC than variety I. These meant the higher organic matter incorporation and its lower erosion from the soil in variety II. Results exhibit immediate increments of SOC in March due to the addition of partially combusted charred material during the fire practice in March. Further fire burnt the surface litter and it resulted in no carbon input from above ground biomass in March. Monthly soil C budget proclaimed that soil of variety I added 87.1 g CO2 during carbon source months to the atmosphere whereas it removed 280.8 g of CO2 during its carbon sink months and caused a removal of 193.6 g CO2 in the year. But studies indicated that variety II grasslands exhibit better carbon sink quality of soil. It removed 216.9 g CO2/year from the atmosphere. Hence *Imperata* cylindrica var. latifolia and *Imperata cylindrica* var. major grasslands have its negative feedback to the global climate change.

P62-01 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Disrupted dispersal in logged tropical forest

BENJAMIN YGUEL[1], BRUNO HÉRAULT[2], SYLVIE GOURLET-FLEURY[3], AURÉLIE DOURDAIN[4], COLIN FONTAINE[5], PIERRE-MICHEL FORGET[6]
[1]Museum national d'histoire naturelle / CNRS, UMR MECADEV-CESCO, F-91800, Brunoy, France
[2]CIRAD, UMR ECOFOG, BP 316, F-97379, Kourou, France
[3]CIRAD, UPR BSEF, 34398, Montpellier, France
[4]CIRAD, UMR ECOFOG, BP 316, F-97379, Kourou, France
[5]Museum national d'histoire naturelle / CNRS, UMR CESCO, 75005, Paris, France
[6]Museum national d'histoire naturelle / CNRS, UMR MECADEV, F-91800, Brunoy, France

Selective logging in tropical forests is restricted to a few species, the so-called commercial species. Among those commercial species, many produce fleshy fruits of large size. These tree species provide food to a large number of mammals and birds that often exclusively rely on these resources. These mammals and birds may also be vital for the demography of fleshy fruit trees because they act as dispersers towards more suitable place for seedling establishment (directed dispersal hypothesis or colonization hypothesis), or they increase seedling survival by avoiding conspecific high densities (escape hypothesis).
Selective logging generally targets large trees, above the legal minimum cutting diameter, that also produce an important quantity of fruits to frugivores feeding in the canopy. Therefore, selective logging may impact frugivore populations in the long-term and in fine may disrupt the dispersal processes of logged species but not only. Indeed, selective logging of the largest - in terms of size and quantity -fleshy fruit producers may impact all fleshy fruit producers in decreasing the abundance of the resources hence creating local extinction of frugivores (the resource concentration hypothesis). Large frugivores feeding on the largest fruits may be more rapidly impacted. Until now studying the effect of logging is not an easy task because logging is generally correlated to hunting pressure.
Based on a multispecies comparison using data from a replicated experimental logged forest with various intensities (and including control plots) at constant hunting pressure, we test the effect of selective logging on seed dispersal of tropical forest trees. Seed dispersal will be estimated as a cluster size using Ripley's K functions. In particular, we will test if dispersal distances of fleshy fruit species in logged plots decrease compared to control plots. We hypothesize that animal-dispersed species with larger seeds are dispersed less far away in treated vs control plots than smaller seeded and non animal-dispersed species. We propose to take into account tree species with different dispersal syndromes i.e. tree species with different seed size among animal-dispersed trees, and tree species with different dispersal mode such as wind-dispersed, mechanically dispersed trees or gravity dispersed trees. We also propose to link the difference in dispersal between disturbed and undisturbed forest with the structural properties of the interaction network.

P62-02 – S62 *Disrupted species interactions and cascade effects in human-modified landscapes*
17:30 – 18:30 – Joffre Area (Level 1)

Feral goats shape the vegetation of Caribbean drylands

MILENA HOLMGREN[1], QUIRIJN COOLEN[1], DOLFI DEBROT[2], KEVIN GEURTS[1], KLAAS METSELAAR[3], HENK-JAN OOSTERHUIS[3],
Barry van den Ende[1], Nikkie van Grinsven[1], Pim van Hooft[1], Asha Vergeer[1]
[1]Wageningen University, Resource Ecology, 6708 PB, Wageningen, The Netherlands
[2]IMARES, The Netherlands
[3]Wageningen University, Soil and Land Management, Wageningen, The Netherlands

Goats were introduced to the Caribbean islands almost five centuries ago resulting in direct and indirect changes in terrestrial and surrounding marine ecosystems. We conducted remote sensing, field surveys and field experiments to quantify the top-down effects of feral goats on the vegetation structure and composition of semiarid Aruba and Bonaire. Goats have reshaped the vegetation profoundly. Temporal comparisons of vegetation maps indicate an increasing dominance of thorny shrubs. Long-term (8 year) goat exclosures reveals strong limitation of tree recruitment by goat browsing as no seedlings and saplings of late successional hardwood tree species grow outside the exclosures. Feral goats also browse on three columnar cacti species limiting the establishment of new individuals and reducing adult fecundity thereby shifting population structure towards adult cacti. Positive interactions between cacti and other thorny plant species seem unable to significantly reduce the negative effects of current levels of herbivore pressure. On the other hand, goats seem to facilitate the dispersal of Opuntia cacti in the understory of current thorny shrublands. Our results suggest that the vegetation of these islands may be shifting from dry forests with pockets of columnar cacti towards an increasing dominance of thorny shrublands. These strong top-down effects of a novel herbivore on the terrestrial plant communities may exacerbate water runoff and soil erosion with deleterious impacts to the marine ecosystems.
Quirijn Coolen[1], Dolfi Debrot[2], Kevin Geurts[1], Klaas Metselaar[3], Henk-Jan Oosterhuis[3], Barry van den Ende[1], Nikkie van Grinsven, Pim van Hooft1, Asha Vergeer[1]

P69-01 – S69 *Free session: Habitat fragmentation and biodiversity*
17:30 – 18:30 – Joffre Area (Level 1)

Landscape heterogeneity effects on plant-pollinators networks in fragmented neotropical forest landscapes

PAOLA MANDETTA TOKUMOTO[1], PATRICIA ALVES FERREIRA[2], DANILO BOSCOLO[2]
[1]Instituto de Ciências Ambientais, Químicas e Farmacêuticas - UNIFESP, Biological Sciences, 09972-270, Diadema, Brazil
[2]FFCLRP-USP, Biology, 14040-901, Ribeirão Preto, Brazil

Most studies about the effects of anthropogenic landscape changes on biodiversity have focused on parameters such as species richness and abundance. Few are those that aim to understand the effects of these disturbances on ecological processes such as pollination, which are important for the maintenance of natural and anthropic ecosystems. Pollinating insects are sensitive to changes in the landscape, what may be one of the leading forces for the global decline of these organisms. In this context, the analysis of plant-pollinators interaction networks allows us to better understand the resistance and resilience of pollination processes against landscape changes. Recent studies show that the abundance and richness of pollinators and agricultural productivity tend to be higher in landscapes that are more heterogeneous and with greater amount of forest. However, there is a necessity to better understand how different types of environments affect plant-pollinator interaction networks with a functional approach. This study evaluated the influence of functional heterogeneity of the landscape on plant-pollinator interaction networks in Atlantic Forest fragments in Brazil. Our main hypothesis is that in more diverse, forested, connected and with higher quality landscapes, we should find more resistant and resilient plant-pollinator interaction networks. For this, we selected 12 landscapes, within a gradient of landscape diversity and forest proportion. In each central forest fragment, we actively collected insects floral visitors and flowering plants to build plant-pollinator networks for each landscape. We analyzed our data using a multiple competing hypotheses model selection approach based on the Akaike Information Criterion - AIC. The plant-pollinator networks was bigger in landscapes with higher proportion of forest; more asymmetrical in landscapes with greater functional connectivity; more modular in better quality and more diverse landscapes; and with greater diversity of interactions in landscapes with higher quality and proportion of forest. To mantain plant-pollinator networks more resistant to species loss in fragmented landscapes, it is important to consider, in addition to the amount of forest, how the composition and configuration of different environments in landscape affect this ecological process.

P69-02 – S69 *Free session: Habitat fragmentation and biodiversity*
17:30 – 18:30 – Joffre Area (Level 1)

Nesting ecology of Odontomachus chelifer (Formicidae: Ponerinae) in fragmented cerrado: investigating potential edge effects

LUIS F. P. SALLES[1], ALEXANDER V. CHRISTIANINI[2], PAULO S. OLIVEIRA[1]
[1]Universidade Estadual de Campinas, Departamento de Biologia Animal, 13083862, Campinas, Brazil
[2]Universidade Federal de São Carlos, Campus Sorocaba, 18052780, Sorocaba, Brazil

Habitat fragmentation by human activity is a major threat faced by natural environments. The Brazilian cerrado savanna is increasingly being subjected to habitat fragmentation and, as a consequence, its natural populations are more and more prone to experience edge effects, such as higher temperature and lower humidity at edges compared to the interior of fragments. Ants are key organisms for seed dispersal and plant population regeneration in cerrado, but how they respond to edge effects is still poorly known. Odontomachus chelifer is a ground-dwelling predatory ant that acts as secondary seed disperser of lipid-rich plant diaspores in cerrado. Previous work provided initial evidence that nests of O. chelifer have greater residence time in the interior than at edges of cerrado fragments. In this study we investigate how edge effects may affect the ecology of this ant. We expected that (1) nests in edges would persist for less time than nests in the interior of fragments; (2) prey availability for O. chelifer (mostly litter invertebrates) would be lower at edges than in the interior of cerrado. Fifty nests were tagged in five sites of cerrado fragments. Each site had 10 tagged nests: 5 in its edge (<15 m into the fragment), and 5 in its interior (> 45 m away from the edge). Sites were 1.5 km apart from one another. Prey availability was assessed using 80 pitfalls (8 in the edge and 8 in the interior of each site). Litter depth - which commonly shows correlation with the abundance of invertebrate prey - was measured both at edges and in the interior of the cerrado. After two months, nest persistence did not differ between edge and interior of cerrado fragments. Prey availability did not correlate with litter depth, and did not differ significantly between edge and interior sites. It is possible that edge effects do not affect O. chelifer nest persistence and prey availability in cerrado within a two-month period. Further investigation should confirm if such an effect can appear in subsequent months. Assessing edge effects on cerrado ants is imperative, and a better understanding of how they respond to habitat fragmentation is crucial to maintain their ecological role in this savanna (CNPq, FAPESP).

P69-03 – S69 *Free session: Habitat fragmentation and biodiversity*
17:30 – 18:30 – Joffre Area (Level 1)

Centennial impacts of forest fragmentation on arthropod biodiversity

DANIEL GRUNER
University of Maryland, Entomology, 20742, College Park, MD, USA

Habitat fragmentation is a major component of anthropogenic global change, yet the duration of the majority of studies are limited to decadal scales. A recent synthesis of fragmentation experiments up to 35 years in duration demonstrated biodiversity reductions by 13 to 75%, with intensification of negative effects over the passage of time. We used the volcanic landscape of the island of Hawaii, where continuous old growth forest was dissected by a series of lava flows 135-160 years ago, as a natural, centennial-scale habitat fragmentation experiment. We studied canopy arthropod communities in fragments separated by a recovering matrix of once-sterile basalt, vary in area 100-fold from 0.1 to 12 hectares. Arthropod community abundance, biomass, and richness increases with area of forest fragments; however, when corrected for higher abundance in large fragments, richness did not differ on the spectrum of fragment size. Along transects up to 100 meters into the matrix, richness and species diversity was invariant. However, evenness declined and species composition shifted strongly with increasing distance into the matrix. The matrix habitat was dominated by a small subset of species that were rare in closed forest, and the totality of successional habitats contributed to greater diversity on the landscape-level. Such studies on centennial scales and longer are needed to understand the recovery and persistence of biodiversity after habitat fragmentation.

P69-04 – S69 *Free session: Habitat fragmentation and biodiversity*
17:30 – 18:30 – Joffre Area (Level 1)

Understanding the effects of coffee management intensity on the dispersal and connectivity of a tropical small mammal

BEATRIZ OTERO JIMENEZ[2], KEVIN LI[1], PRISCILLA TUCKER[2], JOHN VANDERMEER[2]
1North Carolina State University, Department of Civil Engineering, 27695, Raleigh, USA
[2]University of Michigan, Department of Ecology and Evolutionary Biology, 48109, Ann Arbor, USA

Background: Most of the natural habitat in tropical regions exists as scattered fragments embedded in a matrix of different agricultural uses. As a result of this agricultural expansion, habitat loss and fragmentation have become the main drivers of biodiversity loss. Understanding the long-term effects of this agricultural fragmentation on populations is of great importance for the development of successful conservation strategies.Our study uses genetic and landscape data to determine the effect of agricultural management practices on the population structure and dispersal of a common tropical forest rodent (Heteromys desmarestianus).
Methods: We sampled 136 individuals from one forest fragment and 3 coffee farms representing varying degrees of management intensity in southern Mexico. Using microsatellite markers we evaluated the genetic structure of H. desmarestianus in the study area and generated a genetic distance matrix between all sampled individuals. To evaluate the effect of landscape characteristics (e.g., land cover, distance from stream, elevation, slope) we generated landscape resistance matrices for H. desmarestianus individuals based on habitat suitability models. We measured the degree of association between genetic distance and landscape resistance matrices to determine which landscape characteristics are driving population structure and impeding dispersal of this rodent.
Results: Our results suggest that the coffee agricultural matrix can be permeable enough to facilitate H. desmarestianus dispersal and gene flow. However, management practices influence its population structure. Individuals in high intensity coffee farms show higher differentiation and low connectivity due to landscape characteristics that reduce the permeability to movement in this landscape.
Discussion: This study offers an opportunity to increase our understanding of the long-term effects of fragmentation and agriculture management on wildlife at a landscape scale. It demonstrates that agricultural practice influence levels of connectivity and dispersal. As a consequence agricultural management decisions are an important component in ensuring the long-term persistence of fragmented populations in this landscape. Data obtained from this and similar studies in are crucial for the development successful conservation strategies and can also inform agricultural management to help increase connectivity.

P69-05 – S69 *Free session: Habitat fragmentation and biodiversity*
17:30 – 18:30 – Joffre Area (Level 1)

Remnant trees enhance seed dispersal in fragmented landscapes

DANIELLE C T L RAMOS[1], BERNARDO B S NIEBUHR[1], JOHN W RIBEIRO[2], MILTON C RIBEIRO[2], MARCO A PIZO[2]
[1]Universidade Estadual Paulista, Programa de Pós-graduação em Ecologia e Biodiversidade, Instituto de Biociências, 13506-900, Rio Claro, Brazil
[2]Universidade Estadual Paulista, Departamento de Ecologia, Instituto de Biociências, 13506-900, Rio Claro, Brazil

Background. Humans needs have deeply modified tropical landscapes, changing availability and spatial distribution of resources for animals and plants. We need to know how species respond to those changes in order to improve management practices to recover and maintain biodiversity, interactions, and ecological processes and services. In an ongoing study, we aim to understand how seed rain is affected by the interaction between dispersers birds behavior and landscape structure.
Methods. We have completed 360 hours of direct observation of birds movements in five 600 x 600 m landscapes with different percentages of forest cover and cattle grazing pastures in the surroundings of a large Atlantic Forest Corridor of Southeastern Brazil. The studied landscapes also have different number of remnant trees within the matrix, as isolated trees, small groups of trees, and live fences. We studied three groups of abundant seed dispersers birds: Turdus spp. (thrushes), Tangara sayaca (sayaca tanager), and Patagioenas spp. (pigeons). With the observed data, we fitted an individual based model to simulate species movement and seed dispersal within the studied landscapes.
Results. Simulated seed rain pattern was related to the presence of trees, either within forest patches or matrix, as live fences, small groups of trees or isolated trees. Although sayaca tanager and the pigeons flight long distances in open areas, all three bird species mostly crossed the matrix through remnant trees or corridors. The thrushes species flew larger distances in landscapes with fewer remnant trees and forest cover, carrying seeds for larger distances. However, seeds were more homogeneously dispersed in landscapes with more remnant trees and forest cover. More seeds were dispersed between forest patches or to the matrix when there were more remnant trees in the landscape.
Discussion. The bird species studied differs in relation to fruits and forest dependency: the pigeons are the less dependent and the thrushes are the most dependent. Those differences and the distinct movement behavior we observed causes complementary roles promoting the seed rain patterns. Despite those differences, all birds used remnant trees to move and disperse seeds between forest patches and from patches to matrix. Neglected by most conservation projects, our results show that we need to improve matrix quality in order to manage and protect fragmented forests.

P71-01 – S71 *Functional traits in tropical agroecology*
17:30 – 18:30 – Joffre Area (Level 1)

Functional diversity gradients of tree species in human modified landscapes in a Neotropical region: exploring balances between biodiversity conservation and agricultural production

LAURA CEDILLO[E], ALINE PINGARRONI[1], MADELON LOHBECK[2], MIGUEL MARTINEZ-RAMOS[1]
[1]Universidad Nacional Autónoma de México, Instituto de Investigaciones en Ecosistemas y Sustentabilidad, 58190, Morelia, México
[2]Wageningen University, Centre for Ecosystem Studies, 6700, Wageningen, The Netherlands

Keywords: functional diversity, landscape, tropic, mature forest.
Often is considered that functional trait diversity links biodiversity and ecosystem functions. In the tropics, agricultural expansion is the main cause of deforestation and the generator of landscape mosaics where old-growth forest remnants are imbedded in a matrix of different agricultural land uses, patches of second-growth forest (regenerating in abandoned fields) and degraded lands. Because in the future agricultural products will increase in its demand and, therefore, the advance of the agricultural frontier very likely will continue, there is an urgent need to look for human modified landscapes where the conservation of biodiversity (including ecosystem functions) and agricultural production can be conciliated. In this context, here we approach two main questions: how biodiversity (measured with functional trait diversity) change as old-growth forest is reduced in the landscape? And, are there agro-forest landscapes where biodiversity and ecosystem functions can be maintained at high levels?
In a tropical rainforest region of Southeastern Mexico, we quantified the functional diversity of dominant tree species (representing 80% of the total biomass of the whole landscape) in 11 landscapes (3 x 3 km each) differing in the amount of old-growth forest cover (100% to 5%). The functional traits considered were: leaf area, specific leaf area, dry matter content, wood density, mechanical strength of leaves, and seed dispersion syndrome. For each trait a community weight of mean, and different functional trait diversity metrics, were obtained for each landscape. To assess changes in functional trait diversity as a function of the loss of old-growth forest in the landscape, we regressed community weight of means and functional diversity traits values against the fraction of forest cover in the landscape.
Most functional trait values sharply declined when the remaining old-growth forest cover was less than 20%. However, before this threshold there was a wide range of landscape configurations where functional trait diversity was similar to the continuous old-growth forest. Second-growth forests compensated to some extent the loss of functional trait diversity. We propose that biodiversity-functional diversity can be maintained at high levels in human modified landscapes where agricultural land uses, old-growth forest, and second-growth forest patches are intermingled forming diverse mosaics.

P71-02 – S71 *Functional traits in tropical agroecology*
17:30 – 18:30 – Joffre Area (Level 1)

Intraspecific leaf trait variation in tropical agroforestry systems: a case study of shade-grown coffee

MARNEY ISAAC[1], ADAM MARTIN[1], STEPHANIE GAGLIARDI[2], SERRA BUCHANAN[2], KAREL VAN DEN MEERSCHE[3], BRUNO RAPIDEL[4]
[1]University of Toronto, Department of Physical and Environmental Sciences and the Centre for Critical Development Studies, M1C1A4, Toronto, Canada
[2]University of Toronto, Department of Geography, M5S 3G3, Toronto, Canada
[3]CIRAD/CATIE, UMR Eco&Sols, 30501, Turrialba, Costa Rica
[4]CIRAD/CATIE, UMR SYSTEM, 30501, Turrialba, Costa Rica

Understanding plant functional traits is critical for a mechanistic understanding of agroecological processes, with increasing attention on understanding specifically the extent, causes, and consequences of within-species trait variation of cultivated crops. However, to date there are few studies that evaluate how traits vary simultaneously within any crop, across multiple interacting environmental and management-related conditions, and throughout plant development. Using coffee (Coffea arabica var. Caturra), one of the world's most important commodity crops, in Central American agroforestry systems as a case study, we present findings from multiple comparative studies that quantify patterns of intraspecific leaf trait variation across: 1) shade tree diversity gradients, 2) multiple soil fertility levels, 3) different climatic conditions, and 4) plant ontogeny. We demonstrate considerable intraspecific variation in key coffee physiological and morphological leaf traits, that occurs across different environmental gradients and throughout plant development. Generally, patterns of bivariate and multivariate intraspecific trait variation in coffee are consistent with, but weaker than, well-documented interspecific patterns. Our research shows overwhelmingly that mean trait values (even when measured at the site or management-level) are unlikely to accurately represent the breadth of functional variation within crop species (or even cultivars). Understanding how traits covary across integrated scales of environmental variation or biological organization is critical for comprehensively quantifying intraspecific trait variation in crops and plants. In turn, research in this field is critical for i) developing new diagnostics for appropriate management of shade and other agricultural management practices, and ii) understanding how agroecological function responds to both natural and anthropogenic environmental change.

P72-01 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Functional responses of Avocado trees to environment stress

ALEYDA ACOSTA RANGEL, CAROL LOVATT, LOUIS SANTIAGO
[1]University of California Riverside, Botany and Plant Science, 92521, Riverside, United States

Environmental stresses such as drought, salinity, chilling or waterlogging can reduce the growth and productivity of tropical crop trees. Yet how such responses may influence flowering, fruiting, and yield with climate change or by growing species outside of their native range is unknown. Some plants may return to a productive state once the stressor is removed, whereas other plants may acclimate to a new environmental condition through physiological adjustments. On the other hand, unfavorable environments could be strong enough that plant productivity is forcibly reduced. We investigated associations between plant physiological characteristics and environmental stress in Avocado (Persea americana Mill), to determine relationships between productivity, flowering and physiological performance. We developed simulated environments to grow avocado trees under drought, chilling or low radiation stress. We measured physiological and phenological traits in order to find differences caused by these stressors. We also made a review to approach an overview of physiological responses in avocado associated to environmental stress. As a result, our studies and several others have shown how avocado is particularly susceptible to drought, salinity, low temperatures and waterlogging. In general, abiotic stressors affect photosynthesis and growth in different ways. Water deficit, for example, causes a reduction in carbon assimilation and growth, and also causes a trade-off between vegetative and reproductive growth once the stressor is removed. Salinity increases the water use efficiency in avocado but reduces its fruit production. Moreover, chilling affects photosynthesis via photoinhibition and delays both growth and the start of flowering, however, cold temperatures of ten to fifteen centigrade work as a flowering inducer in subtropical climates. Avocado is a crop with an increasing importance worldwide due to its healthy-food standing. Beyond 'Hass', the most commercial variety, nearly 200 avocado varieties are spread around tropical and subtropical areas around the world, thus relationships of functional traits and responses to environmental stressors are to be elucidated.

P72-02 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

The role of matrix composition maintaining the taxonomic, functional, and phylogenetic diversity of birds in agricultural landscapes

ANDREA LARISSA BOESING[1], ELIZABETH NICHOLS[2], JEAN PAUL METZGER[1]
[1]University of Sao Paulo, Ecology, 05508-090, Sao Paulo, Brazil
[2]Swarthmore College, Biology, 19081, Pennsylvania, USA

Mounting evidence demonstrates that biodiversity declines non-linearly with reductions in native habitat cover. Threshold dynamics in diversity-habitat cover relationships are understood to be a function of landscape structure effects on landscape connectivity (ultimately determining species extinction rates). Matrix composition is expected to further influence these threshold dynamics, as it may strongly alter overall landscape connectivity. In addition, evidence suggests different measures of biological diversity may vary in their sensitivity to habitat loss. To test these related ideas, we evaluated how taxonomic (TD), functional (FD), and phylogenetic diversity (PD) of birds responds to native habitat loss along two forest-cover gradients (10-50%) located in distinct agricultural matrix contexts: low permeability (cattle pastures, n = 13) and higher permeability (coffee plantations, n = 10) in the Brazilian Atlantic Rainforest. We quantified avian biodiversity through point counts in four sites within each landscape, and explored the threshold dynamics of TD, FD, and PD for two forest-specialists and habitat-generalists. We quantified biodiversity metrics as a function of forest cover, matrix type, and their two-way interaction through GLMMs. For forest-specialists we found that TD was most strongly affected by native forest cover, while FD and PD were most strongly affected by the interaction between forest cover and matrix composition. For habitat-generalists, we found that the inclusion of either matrix composition or forest cover did not improve upon a null model for any measure of biodiversity. We discuss the implications of these results for our growing understanding of the drivers that structure and maintain biological communities in human-modified landscapes.

P72-03 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Assessing functional traits in nurse plant species in the Tehuacán Valley, México

ALEIDA DÍAZ CASTELLANOS, OSWALDO TÉLLEZ-VALDÉS, RICARDO ÁLVAREZ-ESPINO
UBIPRO, FES IZTACALA, UNAM, Natural Resources, 54090, Tlalnepantla de Baz, Estado de México, México

Background: Nurse plants can modify microhabitat conditions under their canopy, allowing seeds germination and seedling establishment of other plant species, compared with open areas. This plant-plant interaction is well known to be important in arid and semiarid ecosystems, but the knowledge about the role of different nurse species and how they differ in functional traits related to nurse-plant effect is scarce. The aim of this study was to analyze a set of functional traits in a group of fifteen nurse plant species and assess its effect on species richness and abundance under their canopy.
Methodology: The study took place in Tehuacán-Cuicatlán Valley, Mexico. The data collection was performed during april-october 2015. We measured: 1) crown size, 2) plant height, 3) distance to first branching, 5) crown density, 6) spinescence and 7) leaf nitrogen concentration. We recorded identity, abundance and height for each perennial plant growing under the canopy of each individual nurse-plant using two quadrants (0.5 m^2*0.5 m^2) oriented toward north and east. We placed two quadrants from the same size and orientation but in open space as a control. We performed generalized lineal models (glm) with poisson distribution to analyze the effect of functional traits of different nurse-plants on plant species richness and abundance of plants growing under their canopy.
Results: We found that species richness of plants under canopy showed to be different between nurse plant species (X2=88.64; g.l.=14, P= <0.001). Abundance of plants under canopy was different between nurse plant species too (X2= 347.705; g.l.=14, P= <0.001). The best fitting model for plants under canopy included height, crown size, crown density, nitrogen content, and the interaction between height and crown size. Height and crown size as well as its interaction had significant effect on species richness (AIC=651.12, P=<0.05). Crown size, crown density and nitrogen content had significant effect on plant abundance (AIC=1072.6, P=<0.05).
Discussion: Positive interactions among plants are crucial for maintaining species richness in plant communities, particularly in harsh environments. Our results shown that number of species and abundance of plants under canopy between different species of nurse plants was variable, suggesting that not all nurse species have the same effect in community. This effect may be mainly related to nurse-plant size traits.

P72-04 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Population genetics of the tropical African tree Staudtia kamerunensis using newly developed microsatellite markers.

SAMUEL VANDEN ABEELE[1], OLIVIER HARDY[2], STEVEN JANSSENS[1]
[1]Botanic Garden Meise, Spermatophyta - Pteridophyta, 1860, Meise, Belgium
[2]Université Libre de Bruxelles, Evolutionary Biology and Ecology, 1050, Bruxelles, Belgium

Despite the high levels of tree biodiversity in African rainforests, current logging is mainly focused on a selected number of tree species, causing these species to be under severe pressure. To facilitate the conservation and regeneration of these valuable timber species, knowledge on the genetic population structure is extremely valuable. In the current study, the genetic structure of Staudtia kamerunensis populations from Central Africa are analyzed with a set of newly developed microsatellite markers. The software QDD v2.1 (Meglécz et al., 2010) was used to detect microsatellite loci of interest and to select suitable primers from a microsatellite enriched genomic library of Staudtia kamerunensis. Selected primers were tested with different PCR conditions to ensure DNA amplification and readability after which polymorphic loci were retained and combined in multiplexed reactions using Multiplex Manager 1.2 (Holleley and Geerts, 2009). Multiplexed reactions were carried out on Staudtia kamerunensis populations from Cameroon, Gabon, Republic of the Congo and Democratic Republic of the Congo. Results were analyzed with Peak Scanner Software v2.0 (Applied Biosystems) and GeneMapper Software v4.0 (Applied Biosystems). Heterozygosity levels, allele frequencies and the number of alleles were then used to infer gene flow and to assess genetic diversity within and between populations. Finally, these results are discussed in a historic climatological and biogeographical context.

P72-05 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

MacArthur's niche hypotheses revisited: the role of niche space, niche breadth and niche overlap in explaining global patterns of species diversity

DILYS M. VELA DÍAZ[1], MARKO J. SPASOJEVIC[2], JAMES W. DALLING[3], SEAN M. MCMAHON[4], BENJAMIN L. TURNER[5], JOSEPH A. LAMANNA[1], JONATHAN A. MYERS[1]
[1]Washington University in St. Louis, Biology, 63130, Saint Louis, Missouri, USA
[2]University of Colorado, Institute of Arctic and Alpine Research, 80309, Boulder, Colorado, USA
[3]University of Illinois at Urbana-Champaign, Plant Biology, 61801, Urbana-Champaign, Illinois, USA
[4]Smithsonian Environmental Research Center, Smithsonian Tropical Research Institute, 21037, Edgewater, Maryland, USA
[5]Smithsonian Tropical Research Institute, Smithsonian Tropical Research Institute, 0843-03092, Balboa, Ancon, Rep. of Panamá
[6]Collaborators include 27 researchers from 15 plots in 9 countries, Not Applicable, Not Applicable, Not Applicable, Not Applicable
[7]Center for Tropical Forest Science-Forest Global Earth Observatory (CTFS-FORESTGEO) NETWORK

Background: Changes in species diversity across temperate and tropical ecosystems are among the most striking patterns of global biodiversity. Yet the processes that underlie these patterns remain debated. One leading hypothesis is that geographic variation in niche-assembly mechanisms results in higher diversity in the tropics. Theory predicts that tropical communities have greater niche space, more specialist species with smaller niche breadths, or greater niche overlap among species compared to temperate communities. These three niche properties are not mutually exclusive, but are generally examined independently in comparative studies of temperate and tropical diversity. Methods: We tested the relative importance of niche space, breadth and overlap in explaining variation in tree species diversity and richness among 15 CTFS-ForestGEO forest-dynamics plots spanning a latitudinal diversity gradient (11-494 species). For each plot, we calculated multivariate measures of niche space, species niche breadths, and species niche overlap using 13 soil and topographic variables. We compared weighted Akaike's information criterion and relative variable importance values among linear models containing all possible combinations of the three niche properties. Results: When the three niche properties were examined independently, they did not explain differences in species richness or species diversity among forests. In contrast, when niche properties were examined together, niche space and species niche breadths combined to explain 45-70% of the variation in species richness and diversity among forests. Forests with greater niche space and containing species with larger niche breadths had higher species richness and diversity. Niche breadth was the strongest predictor of both species richness and diversity. Discussion: Our results support the hypothesis that geographic variation in niche-assembly mechanisms contributes to differences in species diversity among temperate and tropical ecosystems. Moreover, we found that tropical communities have both greater niche space and more species that are generalized in their niches, suggesting that tropical tree species may be less dispersal limited or more weakly influenced by local environmental heterogeneity or interspecific interactions than temperate tree species. Our study highlights the importance of considering how multiple niche properties at different scales combine to influence global patterns of biodiversity.

P72-06 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Changes in functional leaf traits of Central African rainforest trees

BRECHT VERSTRAETE[1], KENNY HELSEN[2], STEVEN JANSSENS[3], CLAIRE DELVAUX[4], HANS BEECKMAN[4], PIET STOFFELEN[3], PETER HIETZ[5]
[1]University of Copenhagen, Natural History Museum of Denmark, 1307, Copenhagen, Denmark
[2]Norwegian University of Science and Technology, Department of Biology, 7034, Trondheim, Norway
[3]Botanic Garden Meise, Vascular Plants, 1860, Meise, Belgium
[4]Royal Museum for Central Africa, Service of Wood Biology, 3080, Tervuren, Belgium
[5]University of Natural Resources and Life Sciences, Institute of Botany, 1180, Vienna, Austria

Plant functional traits are used in comparative ecology to offer insights in plant ecological strategies. Although their use in ecological research is undeniable and traits are continuously being recorded, it remains unknown what the impact is of the recent climate change on the variability of these functional traits. This is especially the case for Africa since basic trait data for African trees is still lacking. We assessed the extent of recent environmental changes on leaf morphological (specific leaf area, stomatal density) and physiological traits (leaf nitrogen concentrations, leaf delta 15N, leaf delta 13C, and iWUE) of 14 dominant rainforest tree species from the Luki Biosphere Reserve (D.R. Congo). The changes in leaf functional traits over the last century were investigated by comparing historical collections (1919-1959) with specimens that were collected in 2015. Our study showed an increase in SLA, as well as a decline in stomatal density over time. For the chemical traits, we observed a significant increase in leaf nitrogen concentrations and an increase in leaf delta 13C. Changes in SLA, stomatal density, and delta 13C are likely responses to increasing CO_2 concentrations, however, in contrast to other studies, we found no increase in intrinsic water use efficiency. Analyzing the response of plants to past environmental changes is an important tool to study the effects of ongoing changes and may help to understand the future of African rainforests.

P72-07 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Effect of type aquatic habitat on Neotropical tadpoles functional traits distribution

MAINARA XAVIER JORDANI[1], NICOLAS MOUQUET[2], LILIAN CASATTI[3], MARCELO MENIN[4], DENISE CERQUEIRA ROSSA-FERES[3]
[1]Universidade Estadual Paulista, PPG Biologia Animal, 15054000, São José do Rio Preto, Brazil
[2]Université de Montpellier, Institut des Sciences de l'Evolution, 34095, Montpellier, France
[3]Universidade Estadual Paulista, Zoologia e Botânica, 15054000, São José do Rio Preto, Brazil
[4]Universidade Federal de Manaus (UFAM), Biologia, 69077-000, Manaus, Brazil

Background: Trait-based approach provides insights into the mechanisms driving community organization and ecosystem functioning. Anurans are differentially distributed in lentic and lotic aquatic habitats, which are structurally different. Such habitat differences influence the composition, species richness, and abundance of anuran larvae. However, the functional diversity patterns between lentic and lotic tadpoles communities is still unclear. Understand the relation between functional diversity and habitat features is important to guide future conservation decisions.
Aim: Understand the effect of aquatic habitat's type on functional diversity of tadpoles communities. Complementarily, we explored if there is variation in tadpoles functional traits along environmental gradient. We predict that due the continuous microhabitat variation of lentic habitats, in which the depth and aquatic vegetation vary gradually, tadpoles with different phenotypes will coexist. On the other hand, due to unidirectional flow, microhabitats are discontinuously distributed in lotic habitat, keeping tadpoles isolated in the microhabitats, promoting morphological specialization.
Method: We analyzed seven morphological traits in 376 tadpoles from 21 species of 33 lentic habitats, and 68 tadpoles from 10 species in 10 lotic habitats in Atlantic Forest, Brazil. Using functional metrics based on multidimensional space we calculated two metrics of functional richness and two of functional evenness. To compare the functional diversity between lentic and lotic habitats, and to verify if the centroid value of the functional space of each community vary along a canopy cover gradient we employed Linear Mixed Effect Models (LMM).
Result and Discussion: Despite of the different species richness and composition, there is no difference in functional diversity between lentic and lotic aquatic habitat. However, the distribution of functional traits differed. According to our prediction, in lentic habitats it is possible to find tadpoles with different morphological traits. In lotic habitats tadpoles present specialized morphology. Additionally, tadpoles of lentic habitats show different functional traits along canopy cover gradient, which functions as an environmental filter to tadpoles' traits.
Conclusion: Our results present new perspectives for the understanding how the functional traits vary among different aquatic habitats and environment gradients.

P72-08 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Ecological speciation and insect-microbe-plant evolution in the Hawaiian picture-wing Drosophila

CHRISTOPHER YAKYM, ELLIE ARMSTRONG, DONALD PRICE
University of Hawaii, Hilo, Biology, 96720, Hilo, United States of America

Background: For arthropod lineages, host-switching is commonly suggested as an important ecological driver behind diversification and co-evolution. For many lineages, the associated microbiota are a critical interface between host and environment. However, we know little about the potential co-evolutionary role that microbes play during the speciation process. Here, we investigate the interaction between microbiome, insect genome, and plant-host for several species of Hawaiian picture-wing Drosophila (HPWD). This diverse adaptive radiation is ideal to study the insect-microbe-plant interactions because of their well-documented phylogeny and ecology. We predicted that species with the same host plant would have more similar microbiomes than those with different host-plants, as well as more similar suites of genes in regions relevant to host-detection.
Method: To assess HPWD microbiomes we used a 16s rRNA and ITS metagenomics approach and compared both within and between species. We also used de-novo whole genome sequencing of HPWD to investigate the differences between regions under selection between species and gene gain/loss. From this data, we analyzed differential patterns in both genome properties and microbiome composition across various host plants.
Results: We found that HPWD which utilize different host plants have undergone changes gene composition, gene copy number, and microbial diversity. We also identified specific genes that showed strong positive selection between species that may be associated with host-plant switching. Likewise, the microbial communities were most similar in those species that utilized the same host plant. We found unique bacteria and fungi associated with specific HPWD that may contribute to the host-plant association.
Discussion: Host-plant switching of arthropods has great potential to elucidate the intimate role microbes play in speciation and diversification. Here we show that HPWD have undergone both gene gain/loss and significant positive selection for genes that are potentially associated with host-plant switching. Further, we show that there are unique bacteria and fungi that are aligned with specific species. With recent habitat loss and degradation, many Hawaiian plants have become rare or endangered, making it a critical time to understand the crucial interactions between species and their hosts. Future work will require experimental analysis of HPWD preferences for specific microbes and host-plants.

P72-09 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

Determinants of small-scale patterns of belowground diversity in a tropical forest

LUCIE ZINGER[1], AURÉLIE BONIN[2], FRÉDÉRIC BOYER[2], ERIC COISSAC[2], AMAIA IRIBAR[1], DELPHINE RIOUX[2], VINCENT SCHILLING[1], HEIDY SCHIMANN[3], BLAISE THYMEN[1], GUILHEM SOMMERIA-KLEIN[1], CYRIL ZOUITEN[4], PIERRE TABERLET[2], JEROME CHAVE[1]
[1]CNRS-UPS, EDB UMR 5174, 31000, Toulouse, France
[2]CNRS-UJF, LECA UMR 5553, 38000, Grenoble, France
[3]CNRS-INRA-CIRAD-AgroParisTech-University of French Guiana, EcoFoG UMR 745, 97387, Kourou, French Guiana
[4]CNRS-UPS, GET UMR 5563, 31000, Toulouse, France

Background: Spatial patterns of diversity have been extensively documented for plant and animals. Much less is known when it comes to the belowground biota, despite it constitutes a key component of tropical biodiversity and sustains major ecosystem services. In particular, the relative influence of niche-based and dispersal/demographic-based processes in shaping tropical soil communities remains unknown. Here, we aimed at (i) providing a first comprehensive overview of the fine scale distribution of soil biodiversity across the tree of life (ii) assessing what parameters amongst soil abiotic, plant and spatial factors best explain soil richness and composition spatial patterning and (iii) determining how these effects were organised across soil biota groups.
Methods: We conducted a study in a 12 ha plot of a tropical moist forest (Nouragues, French Guiana). We sampled soil cores (top 10 cm) every 10 meters for which archaea, bacterial and eukaryotes communities were characterized using DNA metabarcoding. This method allows compiling molecular taxonomic inventories from DNA extracted from environmental samples using next generation sequencing. Using these molecular inventories, we determined the relative influence of plant, soil abiotic and spatial factors on the spatial patterns of soil richness and community composition using a variation partitioning approach. We conducted this analysis for each of the main soil clades (i.e. archaea, different bacterial or fungal groups, arthropods, annelids, etc.).
Results: We found little to moderate correlation between archaea, bacteria and eukaryotic richness and community composition turnover. Yet, we identified soil Aluminium, Potassium, and site topography as the main common drivers of soil richness and community composition for all clades. Plant effects were overall low or clade specifics. Environmental factors better explained small organisms distribution while larger organisms rather displayed fine-scale or random spatial patterns.
Discussion: Our result constitutes a first overview of the drivers of the spatial patterns of belowground biodiversity in a tropical forest. It further shows that the underlying processes are related to body size, with small organisms distribution being more controlled by environmental factors while larger organisms distribution being more controlled by dispersal limitation. Such findings would help better defining conservation or land management programs.

P72-10 – S72 *Free session: Functional traits in tropical ecosystems*
17:30 – 18:30 – Joffre Area (Level 1)

The leaf economic spectrum in the context of incipient species divergence

GABRIEL DAMASCO, DIANNE QUIROZ, COLBY GEKKO, MARIA JUAREZ, PAUL FINE
Department of Integrative Biology, University of California, 3060 Valley Life Sciences Bldg. #3140, Berkeley, CA 94720-3140, USA

The leaf economic spectrum (LES) has been largely applied to summarize the variation in plant ecological strategies. Based on observed correlations of leaf physiological traits among species, the LES is hypothesized to reflect the adaptation of plants to both small- and large-scale environmental gradients. However, little is known about how LES fits in an evolutionary context, because most research has focused on worldwide species comparisons, rather than examining populations where evolution takes place. Here, we studied a suite of leaf functional traits from populations of Protium heptaphyllum (Aubl.) Marchand, a widespread species complex in the Neotropics, across local and large climatic and environmental gradients. Independent of spatial distance and climatic variability, P. heptaphyllum populations inhabiting nutrient poor and low moisture soils represent slow-growing species that produce long-lived, structurally expensive leaves with a low nitrogen content and a low photosynthetic rate. Sympatric populations across local environmental transitions are phylogenetically more closely related than expected by chance and present contrasting physiological strategies. Our results strongly suggest that leaf functional traits can be as variable within a single species or taxon as cross-species studies. Additionally, the ability to physiologically acclimate across local ecotones favored the expansion of P. heptaphyllum's population size over a wide range of habitat types in South America. Once populations became geographically isolated, genetic structure is triggered in response to low gene flow and reproductive isolation between distant populations. We conclude that intra-specific variation in leaf traits of widespread and dominant populations is an important gateway to plant speciation in the Neotropics.

List of authors

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