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PLANT CONSERVATION AND ACHIEVING THE KUNMING–MONTREAL GLOBAL BIODIVERSITY FRAMEWORK

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EDITORIAL

PLANT CONSERVATION AND ACHIEVING THE KUNMING–MONTREAL GLOBAL BIODIVERSITY FRAMEWORK

Welcome to a very special edition of *BGJournal*, which focuses on the long-awaited Global Biodiversity Framework (GBF), successor to the Aichi targets, and the roadmap for conservation prioritization, planning and action over the next decade. Despite (and perhaps partly because of) the delays in drafting the Global Biodiversity Framework caused by the Covid-19 pandemic, I believe that the GBF is a much stronger framework than its predecessors. The framework has four long-term goals for 2050 related to the 2050 Vision for Biodiversity:

GOAL A seeks to ensure that the integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050. It also aims to halt the human induced extinction of known threatened species and safeguard the genetic diversity within populations of wild and domesticated species.

GOAL B aims to ensure that biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050.

GOAL C focuses on fair and equitable sharing of monetary and non-monetary benefits from the utilization of genetic resources, and digital sequence information on genetic resources, thereby contributing to the conservation and sustainable use of biodiversity, in accordance with internationally agreed access and benefit-sharing instruments.

GOAL D aims to ensure that the GBF is underpinned by adequate means of implementation, including financial resources, capacity-building, technical and scientific cooperation, and access to and transfer of technology including closing the biodiversity finance gap of 700 billion dollars per year.

Delivery of these goals is to be achieved through meeting 23 action-oriented targets encompassing the reduction of threats to biodiversity (Targets 1-8); meeting people's needs through sustainable use and benefit-sharing (Targets 9-13), and; developing tools and solutions for implementation and mainstreaming (Targets 14-23).

The headline target is probably **Target 3**, which aims to ensure that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed. However, arguably of equal importance is the recognition that we need to repair and restore the damage that we have done – **Target 2** aims to ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration. Similarly, **Target 4**, which calls for urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, is acknowledgement that proactive recovery of biodiversity is required to prevent further loss of ecosystems and species.

Targets 2 and 4 are particularly relevant to the botanic garden community given our ability to conserve, grow and manage at least a third of known plant diversity, and it is imperative that we become much more involved in supporting habitat restoration and species recovery. However, our role doesn't end there. For the first time (see page 7), the targets and indicators of the Global Strategy for Plant Conservation (GSPC) are nested in the overall biodiversity framework. There are 35 plant conservation actions proposed for the

Field experience, collecting seed for conservation colletions at the Jardín Botánico Nacional in Havana, Cuba. (Chad Washburn)

updated GSPC, aligned to the GBF targets encompassing protection and restoration of ecosystems (page 34); recovery of threatened species (pages 22, 39, 42 & 51); sustainable harvesting and use of biodiversity (page 18); control of invasive species; mitigating and adapting to climate change; providing social, economic and environmental benefits for people (page 26); managing productive lands sustainably; restoring ecosystem functions and services; integration of biodiversity and its multiple values into policies, regulations, planning and development processes (page 31); ensuring that people are encouraged and enabled to make sustainable consumption choices; strengthening capacity-building and development (page 55), and; ensuring that the best available data, information and knowledge, are accessible to decision makers, practitioners and the public (page 60).

While this edition of *BGJournal* reaffirms the commitment of the botanical community to plant conservation, if we are to achieve real impact, we need to follow the example of the GSPC and reach out to wider society to make sure we are not working in isolation and, better still, to ensure that our efforts are multiplied many times over.

Dr Paul Smith,
BGCI Secretary General

FEATURES

NEWS FROM BGCI

CUTTINGS

Here we present a selection of the most recent news stories form BGCI. Please browse our website to keep up-to-date with the latest news and events from BGCI and the botanic garden community: **www.bgci.org**

The BGCI Team

BOTANIC GARDENS CONSERVATION INTERNATIONAL

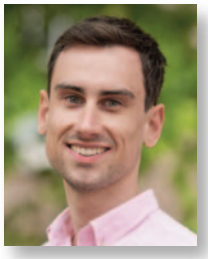
As BGCI increases its support for botanical institutes and work on plant conservation, so the BGCI Team has grown in the last year. Presented below, by alphabetical order, is a brief introduction to our new members of staff and why they are excited to work for BGCI.

Alex Pizzoni: Finance Officer
"I am passionate about the environment and being part of a charitable organisation, which is focussed on biodiversity and plant conservation. As a finance officer, I can utilise my accountancy skills to serve BGCI in a self-giving way and develop knowledge in all aspects of the finance function."

Annelies Andringa-Davis: Education & Training Officer
"It's great to be working for an organisation that is active worldwide and to be able to develop training and educational activities with international teams of botanical gardens that have the potential to reach a huge audience."

Carly Cowell: Director of Conservation Policy and Practice
"I like to see research and science applied and in use, to see the learning cycle and adapting to the dynamics of the natural environment. BGCI is the epitome of this, working with dynamic and passionate people and organizations to make a difference to biodiversity and particularly plant conservation."

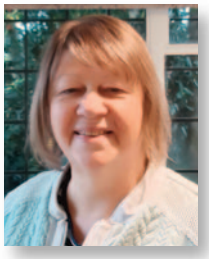
Charlotte Ely: Conservation Services Officer
"I'm very passionate about plant conservation to ensure plant species are protected into the future. I look forward to working at BGCI where I can help plant communities globally by supporting them with funding for projects, especially in under resourced or high biodiversity areas. I'm thrilled to be part of the largest plant conservation network in the world and working alongside other like-minded people."



David Bartholomew: GBS Project Manager
"BGCI provides an important bridge between research and applied solutions that are critical for effective conservation and restoration of the natural world. It is exciting to work amongst a dynamic, knowledgeable and motivated community to realise tangible positive outcomes for nature."

Jake Clifford: Director of Operations
"I like to work in the background making operational systems and processes work smoother, better and faster. At BGCI, I get to do that working towards the incredible vision of a world in which plant diversity is valued, secure, and supports all life."

January Muthoka: East Africa Project Officer
"Plants are the primary source of life and I would love to see all plants saved from extinction and continued thriving. This being one of the BGCI main goals, I love to be part of this agenda and dedicating time to educate the communities who are the key in saving plants because they are the first line of defence."



Karen Turnbull: Human Resources Manager
"BGCI have ambitious and exciting plans and it is the people who work for and with BGCI who will deliver those outcomes. I'm passionate about how we can continue to recruit and retain great people and develop and enable them so that they are able to do their best work."

Magda Svensson: Conservation Assistant Officer
"It has been fantastic to join a team of such passionate conservationists, both within BGCI and all the collaborators around the world. I am proud to be working in an organisation that works towards biodiversity and plant conservation in such a practical and purposeful way".

Sadly in 2023 we also bid farewell to several staff members, some who had been with BGCI for many years.

We wish to thank the previous Editor of *BGJournal*, Suzanne Sharrock for her professional management of *BGJournal* and putting BGCI on the map in the conservation policy arena, and a special thanks to Vivien Isaac for her dedication to BGCI and the team. We wish Kate Marfleet, Miles Kitching, Dan Crowley, Katherine O'Donnell, Phyllida Middlemiss and Katharine Davies all the best in their new careers.

BGCI Accreditation Scheme for Botanic Gardens: Where are we?

BGCI Accreditation Scheme

Launched in 2018 the BGCI Botanic Garden Accreditation is aimed at botanical institutions wishing to establish their credentials as botanic gardens adhering to internationally recognised standards. Assessment criteria encompass leadership, collections management, horticulture, public education, community/cultural activities, conservation actions, scientific research, staff, networking and sustainability. The BGCI Conservation Practitioner Accreditation recognises botanic gardens with a conservation-oriented approach. Advanced Conservation Practitioner Accreditation recognises botanic gardens with a focus on conservation actions that support local, national or global conservation goals. Accreditation is open to BGCI members and non-members and institutions may apply for more than one accreditation.

In 2023 we had 18 new accreditations including gardens in Peru and Ecuador and the reaccreditation process was launched, a joint Italian accreditation launched with forms in Italian and work began on realignment work for the whole scheme.

Visit https://www.bgci.org/our-work/sharing-knowledge-and-resources/bgci-accreditation-scheme/about-the-bgci-accreditation-scheme/

Queen Sirikit Botanic Garden, Thailand

Accreditations for 2023 include:

Reaccreditations:

- National Botanic Garden of Wales (United Kingdom)
- Ljubljana University Botanical Garden (Slovenia)
- Plantentuin Universiteit Gent (Belgium)
- Rotterdam Zoo and Botanical Garden (Netherlands)

BGCI Botanic Garden Accreditations:

- Argotti Botanic Gardens & Resource Centre (Malta)
- Australian National Botanic Gardens (Australia)
- Bernheim Arboretum and Research Forest (United States)
- Cincinatti Zoo and Botanical Gardens (United States)
- Jardín Botánico Francisco Javier Clavijero (Mexico)
- Jardín Botánico - Parque de Las Leyendas (Peru)
- Jardín Botánico Padre Julio Marrero (Ecuador)
- Red Butte Garden and Arboretum (United States)
- Sculpture by the Lakes (United Kingdom)
- St. Andrews Botanic Garden (United Kingdom)
- The Botanic Garden of Smith College (United States)
- Treborth Botanic Garden (United Kingdom)

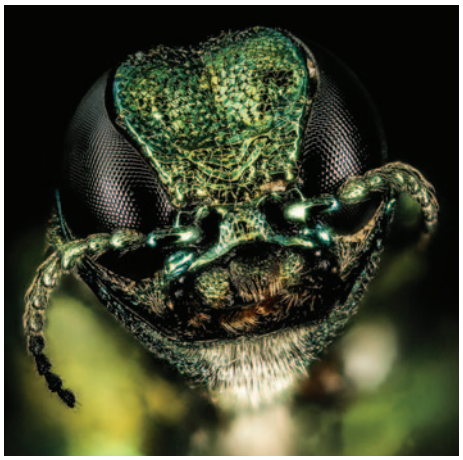
BGCI Conservation Practitioner Accreditations:

- Lauritzen Gardens (United States)
- Queen Sirikit Botanic Garden (Thailand)

Next *BGjournal* Issue

Look out for our next issue of *BGjournal* which will focus on pests and diseases and how botanic gardens are helping fight this battle.

Jardín Botánico - Parque de Las Leyendas, Peru



Emerald Ash Borer, flickr

Authors: Peter Wyse Jackson and Maïté Delmas

CBD COP15 Montreal December 2022

GLOBAL STRATEGY FOR PLANT CONSERVATION

UPDATING THE GLOBAL STRATEGY FOR PLANT CONSERVATION FOR THE PERIOD 2021 TO 2030

The botanical community as always been at the forefront of global plant conservation actions, from the first call to recognize the need for plant conservation in the early 2000s, the establishment of the Global Partnership for Plant Conservation and the development of the Global Strategy for Plant Conservation (GSPC) and through twenty years of implementation to achieve the targets. The global botanical community now enters the next phase of collaboration for plant conservation in the development and implementation of the GSPC Complementary Actions of the Convention on Biological Diversity, Kunming-Montreal Global Biodiversity Framework. The history and progress of the GSPC is given here from those who have been there from the very beginning.

The development and background to the Global Strategy for Plant Conservation

In 2002, the Parties to the U.N. Convention on Biological Diversity (CBD) recognized that plants needed a new programmatic focus within the CBD when it adopted a Global Strategy for Plant Conservation (GSPC) (GSPC, 2002). Thus, the importance of plants was highlighted by the CBD as essential for the functioning of the planet and vitally important to support human livelihoods. In developing the GSPC they were responding to a call from the botanical community to recognize the urgency of having a global framework and strategy to conserve the tens of thousands of plant species and their habitats that were and are threatened in the wild (Blackmore *et al*., 2001).

The GSPC was subsequently updated in 2010 (CBD, 2012) for the next decade. Up to 2020, it included a set of 16 international targets, which are amongst the first global measurable biodiversity targets that have ever been developed by the international community (Wyse Jackson, 2001).

In developing the GSPC, the Conference of Parties (COP) acknowledged the critical role of plants in supporting ecosystem resilience, provision of ecosystem services, adapting to and mitigating environmental challenges, including climate change, and for supporting human well-being. Plants sustain all life on Earth as they maintain environmental balance and ensure ecosystem stability. Through photosynthesis, plants are at the base of most of the trophic chains that sustain life across the planet. Securing a rich and healthy plant diversity in functioning ecosystems is fundamental to the achievement of a sustainable future for humankind where the ecosystem services that plants provide are crucial to our survival (Wyse Jackson *et al*., 2009).

Recognising the notable achievements that followed the implementation of the GSPC targets up to 2020, there was much concern, particularly amongst the botanical and plant conservation communities, and notably by several megadiverse countries too, that without a continued specific focus on plant conservation in the post-2020 period, much vital plant diversity and ecosystem quality and function would be lost. This concern created an important impetus develop a next phase of the GSPC.

Progress in the achievement of the GSPC objectives up to 2020

From 2002 onwards, the GSPC's plant conservation targets guided CBD Parties and the wider conservation community towards many significant achievements.

The GSPC has been an invaluable catalyst for mobilizing and guiding the botanical and plant conservation communities worldwide, stimulating many new actions at global, regional and national levels.

Since 2002, substantial progress has been made in the achievement of many targets at national and international levels. Such progress has been well outlined in various Plant Conservation Reports published since 2002, e.g. Sharrock, 2020 - https://www.cbd.int/gbo5/plant-conservation-report-2020, and

SBSTTA 25 Nairobi 2023

GPPC 2018 Cape Town

highlighted too in the 5th edition of the Global Biodiversity Outlook (GBO5) (SCBD, 2020). The GSPC provided a clear, coherent and flexible framework allowing the development of national responses to the GSPC in a range of countries, including some of the most mega diverse countries, and helped mobilise action amongst a wide range of stakeholders.

Notable achievements that can be linked to the GSPC up to 2020 have included the following:

- National plant conservation strategies based around the targets are focusing the work of some of the world's most biodiverse countries (e.g. Brazil, China, Colombia, Indonesia, Mexico, Philippines and South Africa). Between them, these countries include over 50% of the world's plant diversity. Other countries have incorporated new plant-focused initiatives into their National Biodiversity Strategies and Action Plans using the GSPC as a guide. The development of such strategies has been shown to provide an important mechanism to bring together the wide range of stakeholders involved in plant conservation at the national level.
- An online World Flora of all known plants, supported by over 40 institutions working together in the World Flora Online Consortium, is now available and continues to develop (www.worldfloraonline.org).
- A growing number of companies use the FairWild Standard to ensure the sustainable sourcing of wild harvested plant-based products from countries around the world (www.fairwild.org).
- The Global Tree Assessment has completed Red List assessments for all of the world's tree species (www.bgci.org/our-work/networks/gta/).
- Important Plant Areas are being identified and protected in a growing number of countries and are helping generate plant data to support the conservation work in Key Biodiversity Areas (www.plantlife.org.uk).

GSPC-IUCN Congress Marseille

GSPC 2019 Dujiangyan Conference

The Global Partnership for Plant Conservation

Over the last two decades the GSPC has been well supported by a Global Partnership for Plant Conservation (GPPC). The GPPC is a voluntary partnership of many of the world's leading botanical and plant conservation organisations and institutions. The Partnership was launched in 2004, at the CBD's 7th Conference of the Parties (COP7), in a Decision which also included the establishment of a flexible coordination mechanism for the GSPC that includes the GPPC. The GPPC is provided with a Secretariat by Botanic Gardens Conservation International (BGCI). The GPPC has grown to include about 70 members, including 21 international organisations and 47 national organisations in 21 countries.

The Partnership was created to support the Parties in the implementation of the GSPC and has taken its role very seriously, helping to mobilize innovative and effective new actions for plants and support capacity building throughout the world. The GPPC has been active in many ways in GSPC implementation, including in the preparation of the Plant Conservation Reports and giving visibility to the GSPC in national and international fora. Over the years, the GSPC has also involved thousands of plant conservationists in the CBD process, engaging their efforts, often at community levels and aligning their actions with priorities at national levels.

Developing a post-2020 GSPC

At a GPPC conference held in South Africa in 2018, hosted by the South African National Biodiversity Institute, a GSPC Liaison Group meeting was held to review the GSPC progress and its future. The development of a post-2020 update to the GSPC was proposed. Subsequently, support for an update came from a range of CBD Parties, including at the informal meetings of the CBD's 24th meeting of its Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA 24) and at international plant conservation conferences and consultations, such as those held in China in 2018 and 2019.

It was recommended by SBSTTA 24 that an updated GSPC should take the form of a set of complementary actions in support of the implementation of the Global Biodiversity Framework (https://www.cbd.int/doc/recommendations/sbstta-24/sbstta-24-rec-02-en.pdf).

Following that, at the CBD's COP15 meeting (Kunming, China - 11-15 October 2021 and Montreal, Canada - 7-19 December 2022) the Parties decided to invite the GPPC to:

"with the support of the Secretariat, prepare a set of complementary actions related to plant conservation to support the implementation of the Kunming-Montreal Global Biodiversity Framework, ... to be considered by a meeting of SBSTTA following the fifteenth meeting of the Conference of the Parties."

The justification for a GSPC update based on complementary actions

It has been asked why the GSPC post-2020 is built around a set of complementary actions, rather than with measurable targets, as were included in the GSPC from 2002 to 2020. The main reason for this change is that the international community has been actively preparing a new Global action plan the Kunming-Montreal Global Biodiversity Framework (KMGBF) as an update to the Strategic framework for biodiversity. This challenging plan adopted at COP 15 presents a set of conservation targets for all biodiversity that are due to be achieved by 2030.

GPPC Conference Kirstenbosch 2018

It was recognised that the adoption and delivery of a parallel strategy for plants with a different set of targets would be counter-productive and create confusion and soon lead to its disinterest by the Parties. The complementary actions fully harmonized with the KMGBF can instead be related directly to achieving the plant conservation elements of the KMGBF and each of its targets may be applied specifically to plants and/or their habitats. In addition, the complementary actions in plant conservation can act as effective indicators for the achievement of the broader GBF targets.

The process in the development of the post-2020 GSPC

Following the SBSTTA 24 Recommendation on the GSPC and the Decision of COP 15, work began to develop a schedule of complementary actions. The starting point for these was the draft post-2020 GSPC that had been develop previously by the GPPC. This was edited to become an action, rather than target-based, approach. In this way, the suggestions and inputs provided by GPPC members, and by the representatives of the CBD Parties made at various meetings, could be incorporated into an appropriate draft. When completed, the draft was reviewed and further enhanced by the members of the GPPC and by the CBD Secretariat.

In June 2023, the draft was submitted to CBD Secretariat who provided it to CBD Parties for peer review. All comments received were then incorporated and the plant conservation action framework which was presented at the SBSTTA 25 held in October 2023 in Nairobi. That meeting recommended that the upcoming COP 16 (due to be held in October 2024 in Colombia) should adopt the voluntary complementary actions related to plant conservation, as an update to the GSPC to

2003 meeting in Dingle co. Kerry Ireland where GPPC was recommended

support the implementation of the KMGBF. The plant-related actions taken together represent the third phase of the GSPC [2023-2030].

The text of the SBSTTA 25 recommendation including the schedule of complementary actions is available at the following link: https://www.cbd.int/doc/recommendations/sbstta-25/sbstta-25-rec-04-en.pdf. Further edits to the complementary actions can be anticipated at COP16, but it is likely that they will remain substantially the same.

The SBSTTA 25 recommendation also invited the GPPC:

- to provide guidance on using the monitoring framework for the Kunming-Montreal Global Biodiversity Framework to monitor progress on the implementation of the voluntary complementary actions related to plant conservation, including the identification of its gaps;
- to develop specific indicators for each of the voluntary complementary actions;
- to develop a template for voluntary reporting on progress in the implementation of the voluntary complementary actions.

At this stage we don't yet know what the process will be whereby the GPPC takes this forward but it may be pre- or post-COP16.

Since the important progress made on the GSPC at SBSTTA 25, BGCI has been preparing a set of goals, actions, targets, indicators and milestones for botanic gardens related to the new GSPC, for each of the complementary actions and linked to the GBF 2030 targets. This work has been led by BGCI's International Advisory Council (IAC), which met at the Missouri Botanical Garden, St Louis, 28-30, September, 2023.

The plant conservation framework of complementary actions

There are 35 plant conservation actions proposed for the updated GSPC, aligned to the GBF targets for reducing threats; meeting people's needs and providing tools and solutions. Each one of the actions will be implemented taking into account CBD provisions for fair and equitable access and benefit sharing, and gender equality.

Actions on reducing threats cover ecosystem, species and genetic diversity conservation and restoration, the use of plant species diversity in spatial planning, the use of native species in areas planted for carbon sequestration and in climate mitigation and adaptation. It also includes actions needed to achieve sustainable levels of harvesting and trade in plants and the monitoring and controlling of invasive plant species.

The proposed actions for Meeting people's needs refer to the:

- improvement of livelihoods through the conservation and management of socio-economically important wild plants and their ecosystems in and *ex situ*;
- initiatives to support the efforts of indigenous and local communities to conserve their traditional knowledge, innovations and practices for the conservation and sustainable use of plant diversity, safeguarding and supporting customary and cultural use of these resources;
- the development of biodiversity-rich accessible green spaces in urban areas, with programmes such as urban greening, biodiversity conservation and community gardening initiatives;
- the use of plant diversity to support nutrition, health, livelihoods and well-being.

The Tools and solutions for implementation and mainstreaming include the development, dissemination and access in all countries of:

- comprehensive and authoritative global and national expertise on the floras and the status of known plant species and their natural habitats;
- online information systems and access to documentation and inventories and biological collections through digitisation;
- the development of capacity building, resourcing, networking, institution building and public engagement initiatives to support plant conservation.

Rationales of each of the 'Complementary Actions'

To accompany these complementary actions, an information document was prepared and provided for SBSTTA 25 – (CBD/SBSTTA/25/INF/4). (https://www.cbd.int/doc/c/68b8/ed5d/b5be7f27250b366d17f45c00/sbstta-25-inf-04-en.pdf)

That document outlines technical rationales for each of complementary action, and some possible means of measuring progress. The set of actions is based on the plant conservation priorities and actions identified during the various international meetings and stakeholder consultations mentioned. They also derive from experiences/priorities identified/lessons learnt during the implementation of the previous phases of the GSPC throughout the botanical and plant conservation communities and will be regularly updated. The actions recognise the importance of plant species, their role as both biological and structural elements in ecosystems and their socio-economic importance.

We look forward to the adoption of the updated GSPC at CBD COP 16 and to the continued leadership provided by botanic gardens in its implementation.

Various GSPC policy documents and reports

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Peter Wyse Jackson
President
Missouri Botanical Garden
and Co-Chair of the GPPC

Maïté Delmas
Co-Chair of the Global Partnership for Plant Conservation

Authors: Lauren Jackson and Dr. Tara Moreau

Above: One of hundreds of wishes for nature on the wishing tree at Biodiversity Days 2022 (Ben Scheufler).
Top: A child explores a pop-up pollination station, magnifying the anatomy of flowers to understand the relationship between plants and insect pollinators. Part of the Family Nature Walk event (Tara Moreau).

FEATURED GARDEN

LOCAL ROOTS, GLOBAL IMPACT: GROWING BIODIVERSITY DAYS AT UBC BOTANICAL GARDEN AND BEYOND

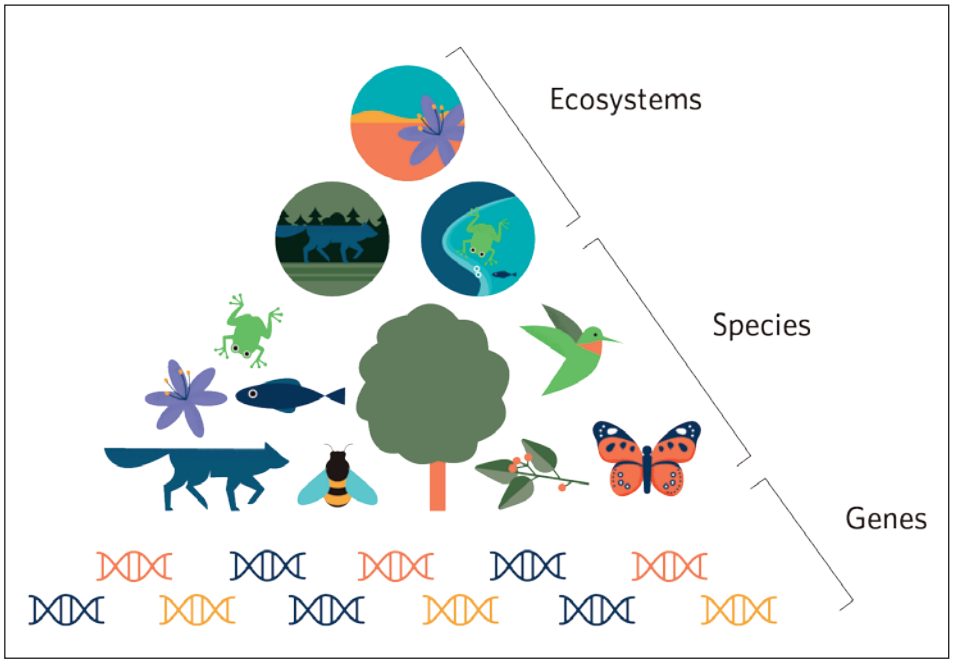
University of British Colombia Botanical Garden grows on the traditional, ancestral and unceded territory of the Musqueam First Nation. Their lands directly overlook the Pacific Ocean and support the growth of a towering temperate rainforest and a living plant collection of more than 50,000 accessioned plants, representing over 7,000 taxa. Since 2021, the Garden has hosted Biodiversity Days, an annual event with a global perspective, guided by the Kunming-Montreal Global Biodiversity Framework (KM-GBF). This event spotlights local biodiversity initiatives and fosters community connections and networks to inspire individuals and groups to take action for a more resilient and biodiverse world.

A key goal of Biodiversity Days was to create a brand for biodiversity on campus. Every year, the Garden has worked with the same designer – Helen Eady – to build out our portfolio of assets, including social media, maps and wayfinding materials, interpretive elements, and more (Helen Eady and Lauren Jackson).

After a BGCI Education Congress in St. Louis, Missouri in 2015, Dr. Tara Moreau returned to Vancouver, Canada and University of British Colombia (UBC) Botanical Garden thinking not just about plants, but also the importance of raising the awareness of one word – Biodiversity. At the Congress, participants learned that google searches for "biodiversity" were on the decline (Troumbis, 2017). This shocking discovery prompted Tara to broaden UBC Botanical Garden's educational curriculum, shifting from a plant exclusive focus to a plant AND biodiversity inclusive focus. In an "aha" moment, Tara clearly understood a critical message moving forward should be to encourage garden visitors to think beyond plants. She also recognized that this work must be carried out in a manner consistent with the priorities and rights of Indigenous Peoples. Only by advancing both biodiversity and cultural diversity can we be successful in protecting bio-cultural diversity for current and future generations.

Botanical gardens are uniquely positioned to engage visitors in learning about biodiversity, and this goal is deeply intertwined with the mission of many gardens across the globe – to preserve and protect plants for the future. UBCBG's vision is for plants to be understood, valued, celebrated, and secure in a healthy, biodiverse world. Established in 1916, UBCBG is Canada's oldest university botanical garden, situated on the University of British Columbia's campus and part of the Faculty of Science. The Garden grows in the lush rainforest of the Pacific Northwest at the western edge of Vancouver, BC, overlooking the Pacific Ocean. Prevailing winds from the west bring moderate temperatures and moist air, creating microclimates that support a collection of 50,000 plants from 8000 accessions, representing 7000 taxa from temperate regions around the world. UBCBG stewards 3 sperate locations – Nitobe Memorial Garden, a traditional Japanese stroll garden, our Plant Nursery, where much of our collection gets its start as seedlings, and the Botanical Garden, which is also home to the GreenHeart TreeWalk (https://botanicalgarden.ubc.ca/visit/greenheart-treewalk/) The Garden's impact extends far beyond the campus and is as a community-hub for research, sustainability education, reconciliation and biodiversity conservation. Internationally, the Garden leads the Global Conservation Consortium for Acer (https://www.bgci.org/our-work/networks/global-conservation-consortia-gcc/), as well as advancing capacity for gardens to promote the UN's Sustainable Development Goals (https://botanicalgarden.ubc.ca/learn/local-gardens-growing-global-goals-storymap/)

Biodiversity Days was established in 2021, with the wish to set in motion at UBC Botanical Garden an annual event to honour the UN International Day for Biological Diversity (May 22).



Biodiversity is described and studied across ecosystems, species and genes. Communicating its complexity is critical to fostering communities that live in harmony with nature (Helen Eady).

Visitors stroll through the David C. Lam Asian Garden, a second-growth forest under-planted with a diverse array of wild collected species from across Asia. (UBC Botanical Garden)

This is the goal of Biodiversity Days – thinking globally, acting locally. We want to raise awareness of this international policy in development, Kunming–Montreal Global Biodiversity Framework (KM-GBF), and the ways that people in the community can take action from the ground up.

Due to the declining interest in biodiversity in 2015, Tara recognized the pressing loss as a global issue. She saw an opportunity to connect with Garden visitors, leaders, innovators, students, volunteers, researchers and community groups in an event to showcase the biodiversity work already underway, and to build momentum for the future. Six years later, this seed of an idea would come to be known as Biodiversity Days.

The annual Biodiversity Days, established in 2021 at UBC, honours the UN International Day for Biological Diversity (May 22). A series of events are held throughout the month of May, bringing together experiences across Metro Vancouver to:

- raise awareness of biodiversity and its importance;
- mobilize action to stop the loss of biodiversity;
- build a generation of stewards, scientists and leaders that actively care, protect and restore biodiversity.

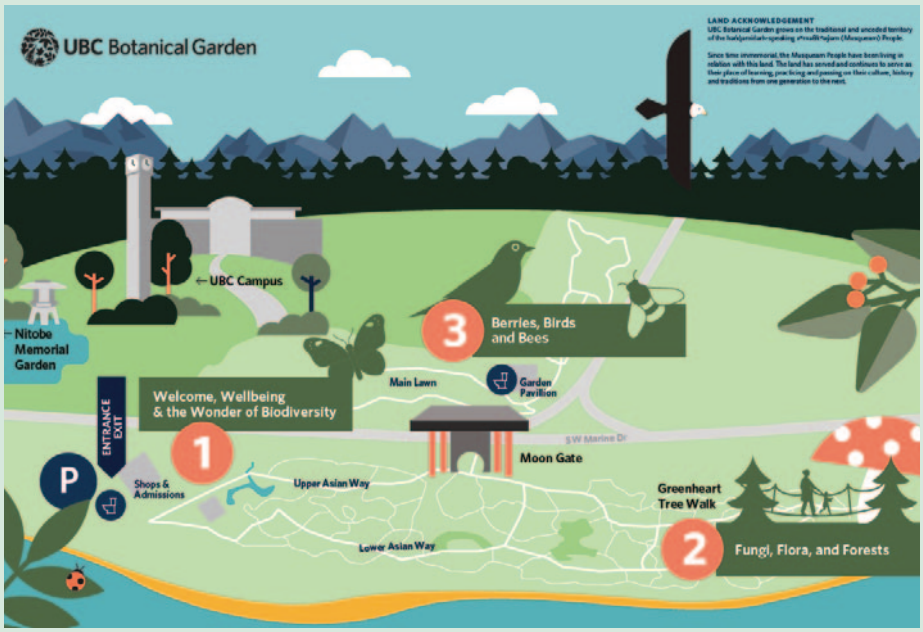
Over the past three years, the event has grown and engaged over 35,000 community members (2021 = 3,800, 2022 = 7,800, 2023 = 23,000), both in-person and online. It features a dynamic series of events and experiences, from student research showcases and educational webinars, to Bioblitzes and field tours exploring birds, bats, nocturnal insects, and pollinators, both at the Garden and on the UBC Campus.

Douglas Justice, Associate Director, Horticulture and Collections, showcases the diversity of cherry blossom trees at Nitobe Memorial Garden (TeaLeaves).

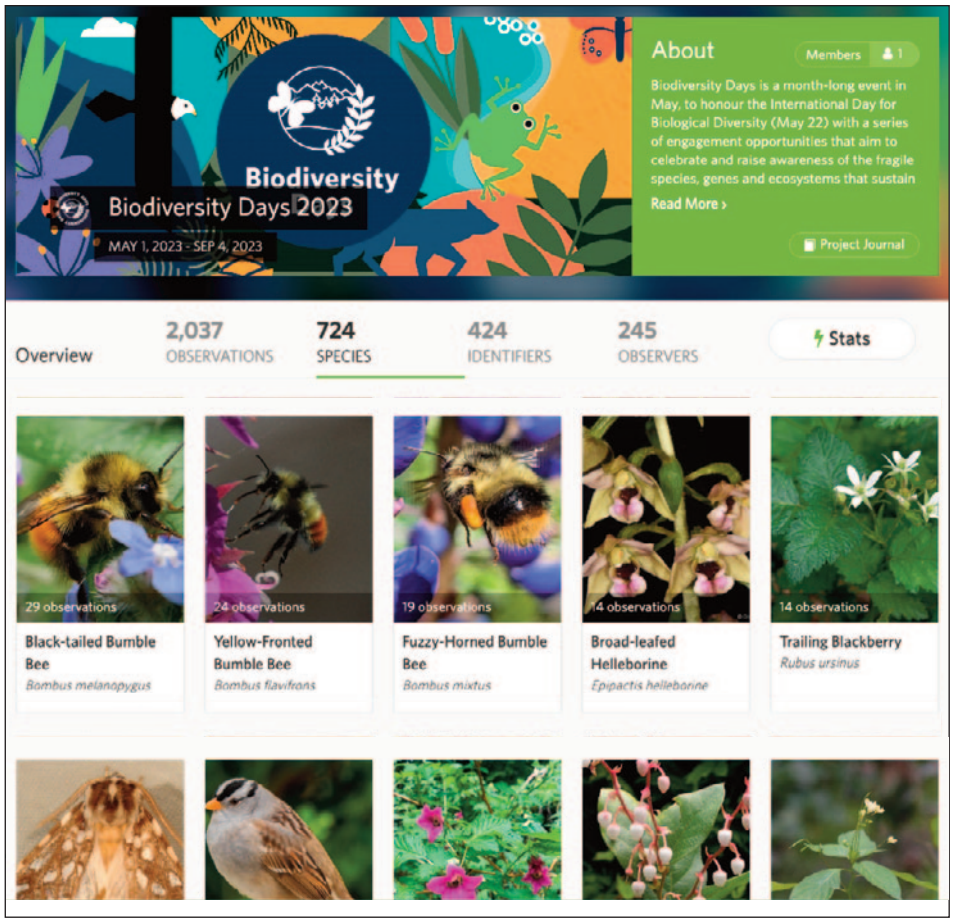
An arial view of UBC Botanical Garden's many gardens and sightlines to the Pacific Ocean (UBC Botanical Garden).

Event Spotlight – Family Nature Walk

The Family Nature Walk is the signature event of Biodiversity Days at UBC Botanical Garden and takes place every year on the May long weekend. It is aimed at hosting children and their families on a fun nature-based adventure in the Garden. Their journey through the Garden explores the world of biodiversity, the delicious diversity of food plants and their pollinators and the carbon and water flows that sustain the biosphere at pop-up education stations. Up high in the treetops, families traverse the GreenHeart TreeWalk to experience biodiversity from a different perspective. To add to the excitement, children who join the Family Nature walk receive a special 'Kids Nature Kit', complete with tools to discover biodiversity. Included in the kit is a uniquely designed children's map to guide them on their way.



A kid-friendly map of UBC Botanical Garden, designed by Helen Eady, to guide children and families on their adventure through the Garden during Family Nature Walk (Helen Eady).



Throughout Biodiversity Days 2023, community members were encouraged to use Citizen Science apps such as iNaturalist to monitor biodiversity in their local areas. This project page was created to track UBC campus observations over the summer (iNaturalist).

Biodiversity Days is led by UBC Botanical Garden, and hosted in collaboration with UBC SEEDS Sustainability Program, UBC Farm, Nature Vancouver and the Beaty Biodiversity Museum. This event would not be possible without their support. Growing partnerships is crucial to the success of Biodiversity Days, and the Garden's mission to raise awareness and mobilize action. By tapping into partnership networks, Biodiversity Days is able to share ideas, information, knowledge and best practices - at a time when the world needs it the most. In doing so, UBC Botanical Garden is fostering synergies in the community and aims to amplify the significant efforts that are underway to ensure that, by 2050, the shared vision of living in harmony with nature is fulfilled. Founding partner Liska Richer, manager of UBC SEEDS Sustainability Program - https://sustain.ubc.ca/teaching-applied-learning/seeds-sustainability-program, shares, "*Partnering with the world-renowned UBC Botanical Garden on the critical topic of biodiversity has allowed UBC SEEDS student researchers to showcase their biodiversity research and solutions to a broader audience, and connect directly with engaged practitioners, researchers and community members. Biodiversity Days provides an important space to build networks and share information about the many efforts underway in our community to effect change, and raise awareness of biodiversity, one of the critical issues of our time.*"

SEEDs' Climate Response Applied Research Coordinator Georgia Stanley, and Biodiversity Days Student Co-Chair Alex Wong opening the Urban Biodiversity Action: Student-Led Research Showcase where participants learned about a range of applied research collaborations on UBC Campus (Ben Scheufler).

UBC Botanical Garden has grown the reach and impact of Biodiversity Days, by increasing the variety of events and community engagement activities. The goal is to continue this celebration through to 2050, keeping in line with the vision of the KM-GBF. This ambition is our greatest driver but brings with it unique challenges. Event programming requires a significant amount of resources, and student and staff time, and we question how to sustain this event for years to come. Since its founding, the event has been generously supported by donors who are interested in increasing the Garden's reach and accessibility for new audiences. The Garden is also looking for other ways for the event to earn revenue and be resilient in the coming decades. May is also a big transitional time for the university where things slow down campus. Our student staff are graduating and growing into new opportunities, and faculty are busy with fieldwork. Despite these ongoing challenges, awareness of biodiversity both locally and globally is growing, but we can't stop there. We know that to halt the loss of biodiversity and reach the KM-GBF targets, we will need transformational change.

The hope for Biodiversity Days in the future is not just that it continues at UBC Botanical Garden to 2050 and beyond, but that all groups and organizations involved in conservation rally around the idea of thinking globally, acting locally. For botanic gardens, there are many opportunities to showcase and expand our networks, with the UN Day of Biological Diversity (May 22) as a time to reflect annually and build a culture that stewards and celebrates biodiversity. Tara notes "Whether you are celebrating Biodiversity Days in your own community, or creating something new, we hope to inspire international conservation groups to recognize their power to implement the goals of the Global Biodiversity Framework in their community, and uphold the voices of individuals, organizations and institutions who are already doing this work."

UBC Botanical Garden staff and Forestry undergraduate student Kai Owa shows off the whishing tree – full of hopeful messages for the future of our planet, written by children participating in Biodiversity Days (Ben Scheufler).

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To learn more about Biodiversity Days, visit our event page https://botanicalgarden.ubc.ca/news-events/events-activities/biodiversity-days-2023/ and read our 2023 Annual Report: https://botanicalgarden2015.sites.olt.ubc.ca/files/2023/08/2023-biodiversity-days-report-resize.pdf.

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INTERVIEW

STEVEN BLACKMORE

Professor Stephen Blackmore is the current Chair of the BGCI Board, and he was the 15th Regius Keeper of the Royal Botanic Garden Edinburgh and was appointed Her Majesty's Botanist in Scotland in 2010. In 2011 he was appointed a CBE for "services to plant conservation", but it is his experience working with the Convention on Biological Diversity (CBD) and the Global Strategy for Plant Conservation that is the focus of our interview.

Given your history with the GSPC, can you share the inspiration behind initiating the GSPC?

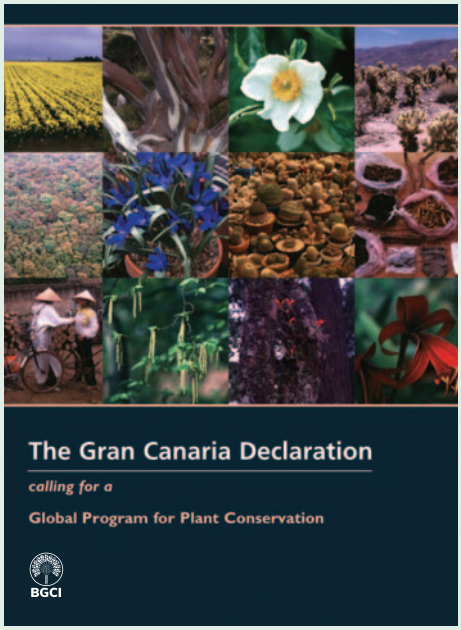
In 2000 I was one of the 16 authors from 14 countries who wrote the **Gran Canaria Declaration**. Our mounting concern for the plight of plants led us to draft the GSPC and work to get it adopted under the auspices of the CBD. Stella Simuyu, from Kenya, tabled our proposal, (which was not on the original agenda) from the floor of CBD 5th Conference of the Parties (COP5) in Nairobi. It took a lot of conviction and effort by many people to embed the GSPC into CBD. We are now coming up to COP16 and the GSPC is firmly placed on the agenda.

What have been your favourite moments from the past 20 years of CBD & GSPC? Are there any specific moments or interactions with the GPPC and GSPC that stand out?

After ten years of the GSPC, the botanical community faced the challenge of winning support for a second phase of the GSPC. As a member of the UK delegation to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) meeting which recommended adoption of phase 2 by the CBD, I remember the intense lobbying that went on behind the scenes and the camaraderie of the highly international group who pushed the GSPC forward. It was inspiring to see how a small number of determined botanists from around the world could have such impact.

3. How has the botanical community responded to the GSPC in the past? In what ways have you seen it contribute to the overall CBD Targets?

The GSPC has had more impact than I ever imagined. Many botanical gardens were already engaged in conservation before it came into being but the GSPC provided a focused framework for action which was soon mirrored in the strategic plans of botanic gardens internationally. The previous Target 8, calling for at least 75% of plants to be protected in ex *situ* collections, had a profound impact on the plants in cultivation at many gardens. At the Royal Botanic Graden Edinburgh, where I was at the time, we exceeded this target and dozens of Scotland's rarest plants went on display for the first time.



The GSPC involves collaboration across various organizations. How do these partnerships enhance the impact and reach of the CBD GBF targets?

The GSPC could never have happened without a huge level of international collaboration and the *Global Partnership for Plant Conservation*, with its Secretariat at BGCI, has been at the heart of this global movement. Reporting on the GSPC has been optional for parties to the CBD but a series of progress reports published by BGCI over the years have helped gain recognition of the GSPC as one of the CBD's most successful programmes.

Reflecting on past targets, what challenges have been encountered, and how has the CBD/GSPC addressed or learned from them?

The greatest challenge has always been that, although plants are our life support system, few additional resources have been committed to funding plant conservation. Fortunately, botanic gardens have risen to the challenge. However, for me the biggest lesson learned is that we must work tirelessly to explain the importance of plants and that we have the technical ability to protect them when such efforts are given the priority they deserve.

Looking ahead, what is the vision for the future of GBF and GSPC? How do you see it evolving to meet the changing needs?

I think that plant conservation will go from strength to strength within the GBF. It feels to me that plant conservation is now central to biodiversity conservation and no longer a sperate programme, with plants outside, clamouring for attention. BGCI has grown and evolved too – refining its information systems to deliver precisely targeted information, growing its regional offices and stepping up to new challenges such as championing the Global Biodiversity Standard.

Ripe fruit of *Y. zenii*

ARTICLES

Authors: Anurag Dhyani, S Suresh, K C Abinlal, Céliane Duprey, S Bindu

CULTIVATING TRANQUILITY: THE ART AND SCIENCE OF SANDALWOOD CONSERVATION

Fruiting twig of Sandal (K C Abinlal)

Sandal seeds (K C Abinlal)

Summary

This article delves into the integral role of Indian Sandalwood in global conservation efforts, aligning with the Convention on Biological Diversity, Global Biodiversity Framework targets and the Global Strategy for Plant Conservation. The botanical marvel, deeply rooted in India and Southeast Asia, dynamically adapts to various environments. Emphasizing its transformation into several aromatic wonders and medicinal secrets, this article addresses challenges such as over-harvesting and smuggling, leading to the species being labelled "Vulnerable" by the IUCN. Seedling production initiatives and plantations emerge as beacons of hope, showcasing a scientific ballet for Sandalwood's legacy. The narrative concludes by highlighting sustainable harvesting's melody as key to species conservation, harmonizing present needs with future preservation in nature's symphony.

Global Conservation Alignment: A sustainable approach

Present work on Indian Sandalwood stands as a beacon, aligning seamlessly with global conservation efforts outlined in the Convention on Biological Diversity (CBD), Global Biodiversity Framework (GBF) targets, and the Global Strategy for Plant Conservation (GSPC) set of Complimentary Actions. As we explore the world of Sandalwood, our comprehensive approach addresses multiple aspects crucial to biodiversity conservation. Our initiatives contribute specifically to Target 5- the essence of sustainable harvesting and our implementation includes GSPC Action 2- ecological restoration practices, Action 4- plant species conservation, and Action 5- sustainable harvesting and trade in plants. The delicate dance between nurturing these iconic trees and respecting the ecological balance vibrates with the broader global agenda, nurturing a harmonious coexistence between human activities and the preservation of our planet's invaluable biodiversity. Our commitment extends beyond the fragrance of Sandalwood; it encompasses a sustainable legacy for future generations, intertwining with international aspirations for a healthier, more resilient global ecosystem.

Natural habitat of Sandal- Marayoor (K C Abinlal)

Sandalwood: A botanical marvel

Sandalwood, scientifically known as *Santalum album* L., is like a natural wonder deeply rooted in the heart of India and Southeast Asia. Imagine a towering evergreen giant, stretching up to 15 meters, with its roots delicately mingling with nearby plants, forming connections for water and nutrients. This captivating tree, belonging to the Santalaceae family, graces a variety of landscapes in Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, and Kerala. What makes it truly special is its incredible ability to adapt. From sea level to 1800 meters, Indian Sandalwood thrives in different environments, facing challenges like 600-1600 mm rainfall and enduring cold weather with extended dry spells. Its roots explore various soils, from red ferruginous loam to sandy, clayey, and black soils. Sandalwood, like a botanical chameleon, transforms from a shade-loving early stage to a sun-basking maturity. It's more than just a tree; it's a dynamic force intricately woven into the ecological fabric of its diverse homes.

Active participation of local community for transplatation (K C Abinlal)

Sandalwood's aromatic and medicinal wonders

Sandalwood, often addressed as the crown jewel of the woods, is more than just a tree– it's a treasure trove of aromatic wonders and medicinal secrets.

Interestingly it takes 25 to 30 years for the Sandalwood tree to mature into its prime, boasting a trunk with a circumference of around 45 cm. That's the magic moment- the heartwood, ranging from pale yellow to rich red, becomes the source of the coveted Sandalwood oil. The older the tree, the thicker the trunk, and the more of that precious essential oil it produces. This oil has a soothing aroma, a beauty treatment for the skin, and an anxiety-soothing elixir that also works against aging and skin inflammation. In India, it's not just a wood; it's a symbol of protective powers, believed to enhance meditation and bring tranquillity. Beyond its aromatic allure, Sandalwood oil takes the spotlight in cosmetics, perfumes, and soaps. And here's the surprising part – it's not just about smelling good; it's been a trusted remedy for everything from fever and piles to mental disorders and skin issues. Additionally, this versatile wood has its artistic side; it's a carving maestro, shaping gods, mythological figures, jewel cases, and more.

Sandal seed germination with the host plant Touch me not in polybag (K C Abinlal)

Global demand for Sandalwood

In India, we're talking serious Sandalwood stats: 1000 tons of heartwood and 40 tons of coveted oil is produced annually. Sandalwood oil, made up an impressive 25% of export revenue for essential oils, priced at INR 3 lakhs per kilogram. Now, onto the global stage – the Sandalwood oil market is rocking at 115 million USD, set to hit a jaw-dropping 190 million USD by 2028. But here's the kicker –

the world craves 6,000 to 7,000 metric tonnes yearly, yet India, our aromatic powerhouse, only produces 200 tons.

Add in other nations, and we barely hit 400 tons, leaving a fascinating gap of nearly 5,400 tons. The scent of success is in the air, and the global demand is a symphony reaching new heights.

Conservation challenges

India now faces a daunting challenge— a significant decline in the number of harvestable Sandalwood trees. The late 20th century saw a relentless over-harvesting spree, pushing this iconic species dangerously close to extinction. In response, the Indian government took decisive action, imposing restrictions on legal harvesting. However, this move unintentionally opened the door to a surge in smuggling activities, with Sandalwood trees being taken from their natural havens. Adding to the threats are forest fires, a shortage of seed-bearing trees, the dormancy of seeds, and habitat degradation due to changes in land use—all contributing to the rapid decline of wild Sandalwood populations. In the eyes of the International Union for Conservation of Nature (IUCN), *Santalum album* now carries the label "Vulnerable." It's a call to action, a plea to protect this precious resource from fading into extinction.

The production of seedlings and their reintroduction into both natural and near-natural habitats, along with the establishment of purposeful plantations, emerges as a beacon of hope.

It's time to take steps to ensure the survival of this valuable species.

Hopeful initiatives: Seedling production and plantation

In Kerala, India, the Jawaharlal Nehru Tropical Botanic Garden and Research Institute, with support from the Kerala Forest Department, has initiated a vital program. The valuable insights gained from this project have the potential to break down barriers in seed propagation, opening the door to large-scale seedling production in nurseries. These resilient seedlings, born from this scientific initiative, are poised to strengthen natural populations, bring life to new habitats, and thrive in purposeful plantations. It's like a scientific ballet—from collecting seeds to testing their viability, studying germination, and the grand finale of transplantation and monitoring saplings.

Scientific ballet: from seed collection to transplantation

Embarking on a journey to Marayoor, roughly 320 km from Thiruvananthapuram, the capital city of Kerala, felt like stumbling upon a treasure trove of Sandalwood wonders.

Extensive literature surveys, field expeditions, and delving into major herbaria unveiled that Marayoor boasts the largest population of Sandalwood in the state. The soul of this endeavour lies in the seeds, sourced from the Indian Institute of Wood Science and Technology (IWST), Bangalore and the Marayoor Forest Department. These seeds, with remarkable 10.13% moisture content have a robust 80% viability. Sheltered in airtight polythene and cotton bags, they endured both refrigerator and room climates (4±2°C and 30±2°C). The goal ? To figure out the best way to keep the seeds safe for an extended period. The solution: 4°C was deemed the optimal temperature, and cotton bags emerged as the winners!

Planting of saplings (K C Abinlal)

Delving into the realm of Sandalwood growth, our exploration of different potting mixes revealed a winning formula: soil, sand, and cow dung in a harmonious 1:1:1 ratio. The seedlings revelled in this mix, showcasing not only a high survival rate but also impressive growth –in terms of plant height, thicker stems, and proudly displaying an abundance of leaves.

Sandalwood's perfect host

However, the semi-parasitic nature of Sandalwood called for companionship in the form of a host plant. Introducing the contenders: three Fabaceae members – Touch-me-not (*Mimosa pudica*), Rattleweed (*Crotalaria retusa*), and Pigeon pea (*Cajanus cajan*) – and Brazilian Snowflower (*Alternanthera ficoidea*) from the Amaranthaceae family. We closely examined their characteristics, from seed germination time to survival after pruning, in a quest to identify the perfect host. After six months of careful observation, Pigeon pea and Brazilian Snowflower emerged as perfect companions. The growth performance of Sandalwood seedlings showed little disparity between the two hosts, but the preference tilted toward Brazilian Snowflower. Why? Because they could be effortlessly propagated through vegetative means and hold an impressive survival rate of 98.90% after pruning. It's a tale of companionship in the green world, where the right mix and the perfect host pave the way for Sandalwood's flourishing legacy.

Polybag method triumphs

In the pursuit of optimal Sandalwood seedling production, two contenders entered the arena: the sand bed method and the poly bag method. The outcome? Seeds directly sown in poly bags took center stage, displaying superior survival rates and earning the crown for large-scale sandalwood seedling production. Why? Because when seedlings are cultivated in sand beds and then transplanted into poly bags, they encounter the dreaded transplantation shock. This shock can be neatly avoided with the poly bag method.

The nursery stage was nothing short of an experiment. Seedlings were given three distinct homes: the mist house, a closed poly house maintaining high humidity and temperature; the conservatory shed, offering low humidity and medium sunlight; and the open house, a simple structure covered with shade net on the sides, leaving the top open. All seedlings were accompanied by the Brazilian Snowflower. Monthly monitoring over a year tracked their survival percentage, stem height, and leaf size. In the mist house, seedlings burst into an impressive display in the initial six months, flaunting tall stems, ample leaves, and a robust survival rate. However, the euphoria fell as only 39.27% of seedlings survived after six months. On the other side of the spectrum, the conservatory shed housed seedlings with a survival rate of 86.29% after the same period. The recommendation ? Nurture seedlings in the mist house for the first six months, and then transition them to the conservatory shed. This seems to be the winning formula for optimal growth and survival.

The perfect conclusion to this horticultural tale: poly bag cultivation with Brazilian Snowflower as the host plant stands out as the cost-effective champion, minimizing seedling damage during transportation.

It's a journey of trials, triumphs, and the fine art of nurturing Sandalwood dreams from seed to sturdy sapling. The careful choices made along the way, from seedling companions to nursery environments, all contributed to the success of this endeavour, making it a truly remarkable journey in the world of Sandalwood cultivation.

Transplantation triumph: Collaborative conservation

Embarking on a green mission, 1600 Sandalwood seedlings, standing tall at an average of 50±4.28 cm, set out for the Edamon section of the Thenmala range in Kollam district, Kerala. Accompanying them on this journey was the trusty companion, Brazilian Snowflower. Their destination: an abandoned Eucalyptus plantation, chosen for its sloping terrain and ideal sunlight. In this lush haven, where various plant species coexist, the ground flora elegantly dominates the landscape. The transplantation process unfolded, with 1x1x1m pits welcoming the seedlings at 10 m intervals across a sprawling 2.5-hectare canvas. The stage was set for nature's experiment as these saplings

Saplings ready for transplatation
(K C Abinlal)

settled into their new home, closely watched for signs of growth and survival. Notably, this transplantation endeavour was completed with the active participation of the local tribal community, adding a collaborative and community-driven dimension to the conservation efforts.

Sustainable harvesting: Key to conservation

Amidst this ecological ballet, a crucial note resonates—sustainable harvesting holds the key to species conservation. It's not just about meeting the demand for the finest heartwood; it's a commitment to ethical practices that honour all plants, people and the planet. In this verdant tapestry, the seeds of conservation are sown, and the dance of growth and preservation continues. Balancing the needs of the present without compromising the future is the melody that harmonizes with the green symphony of nature.

Acknowledgement

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PRESERVING BOTANICAL DIVERSITY IN CENTRAL ASIA: PROPOSALS FOR A SHARED CONSERVATION STRATEGY

The Ili River valley has a special canyon-like structure. Flowing in the zone of deserted steppes and semi-deserts, it is essentially a refugium for many species of plants and animals.

Central Asia, consisting of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, has immense global importance for biodiversity conservation. This region boasts a remarkable diversity of flora and fauna. It contains approximately 9,341 species-level taxa of higher vascular plants, spanning 1,288 genera and 161 families. Furthermore, its fauna is equally impressive, with around 900 vertebrate species and over 20,000 invertebrate species.

Central Asia's mountainous landscape region, particularly the Tien Shan range, is recognized as a biodiversity hotspot. These areas exhibit high levels of endemism and are home to ecosystems classified as vulnerable and critically endangered. There are 871 species and subspecies of vascular plants that are unique to this region. Kyrgyzstan hosts the highest number of endemic species, with 225 national endemics totaling 507 taxa. Kazakhstan is only slightly behind — 205 and 485, respectively. Uzbekistan and Tajikistan also have significant endemism.

The exceptional species diversity in Central Asia can be attributed to the complex origins of its flora and fauna, the presence of mountainous terrain, and the unique mesoclimatic conditions in the region. However, despite its ecological significance, Central Asia faces significant socio-economic and political fragmentation, with varying degrees of anthropogenic pressures across different areas. Central Asia's freshwater ecosystems are among the most threatened globally. Human activities are causing substantial stress on these ecosystems, including those in steppe areas.

The habitat of the *Tulipa ostrowskiana* is threatened by the southward expansion of the city of Almaty.

In the arid expanses of Central Asia, turanga poplar forests (*Populus diversifolia, P. pruinosa*) thrive along ephemeral and perennial watercourses and floodplains. Their visage occasionally mirrors that of a savannah, creating a captivating landscape amidst the desert terrain. Our ancestors called the turanga a "sacred tree" that must be preserved and passed on to descendants, locals say.

The natural plant communities housing wild ancestors of cultivated fruit and nut trees, unique to the region, have seen a drastic 90% decline in the last 50 years. Globalization and climate change have exacerbated the introduction of invasive and alien species into these ecosystems. Overgrazing becomes critical for grass communities of steppes, semi-deserts and mountain meadows. Conservation efforts in the region have predominantly centered around charismatic megafauna, such as big cats and ungulates, while many threatened plant species receive less attention.

Despite increasing numbers of endangered plant species, the existing conservation measures have been deemed insufficient to reverse negative trends effectively. The IUCN Red List, a widely used tool for assessing extinction risk, has limited applicability in Central Asia due to a shortage of regional assessments. Only a small fraction of the region's endangered plant species are found within specially protected natural areas, which lack adequate territorial protection.

Conservation efforts rely significantly on the establishment and preservation of natural habitats within protected areas. However, creating new protected areas can pose challenges, given intricate bureaucratic procedures and resistance from local communities with vested interests in land use. In Central Asia, researchers and conservationists encounter global and regional obstacles when striving to implement an ecosystem approach to vegetation conservation, often conflicting with the prevalent resource-based approach.

The region has a traditional vegetation classification system based on the dominant approach. It is well suited for geographical zoning, but its use for applying international plant conservation standards is difficult. Eastern Europe and Russia have already switched to an ecological-floristic classification system, which is more correct for conservation purposes. It would be reasonable to strive to use this approach in Central Asia as well.

The blossoming of *Viola acutifolia* graces the landscapes surrounding Almaty and throughout the lowlands of Central Asia, unfolding its delicate beauty from April to early May.

A collaborative spring expedition, led by botanists and naturalists, ventures into the buffer zone of the renowned Altyn-Emel National Park. The Institute of Botany and Phytointroduction takes the helm as the orchestrator of the initiative titled "Biodiversity of Semirechye: Vulnerable Species, White Spots," demonstrating its commitment to citizen science.

The endemic *Iris kuschakewiczii* is listed in the Red Data Book of Kazakhstan, but its threat of extinction has not yet been assessed according to IUCN criteria. Only 6% of the country's flora is represented on the IUCN Red List. The situation is similar in other Central Asian countries.

In Kazakhstan, genetic reserves were established in 2006-2014 with UNDP support for the conservation and restoration of Populus pruinosa. These are small fenced areas of 2-6 hectares.

Institutional factors contribute to poor natural resource management in the region, as identified in the Regional Biodiversity and Ecosystem Services Assessment Report for Europe and Central Asia. The Kunming-Montreal Biodiversity Framework for 2022–2030, adopted by the UN Convention on Biodiversity, presents an opportunity to incorporate evolutionary potential and history of species into biodiversity policy. The global trend in conservation is shifting from mere preservation to ecosystem restoration. Additionally, the UN has declared 2021–2030 as the Decade of Ecosystem Restoration. There is now more potential to engage scientific volunteers, including naturalists and nature enthusiasts, to collect biodiversity data, opening new avenues for flora research. Public awareness and education initiatives are crucial.

Populus diversifolia has different leaf shapes on young and mature shoots. The leaves of the crown of *Populus diversifolia* are serrated, and this is also how this species differs from *P. pruinosa*.

The Institute of Botany and Phytointroduction in the Republic of Kazakhstan is convinced of the need to develop a comprehensive strategy for the conservation and restoration of vegetation cover in Central Asia, encompassing various aspects such as biodiversity study, threat assessment, data digitization, species risk assessment, habitat protection, species reintroduction, legislative improvements, public engagement, international collaboration, and sustainability efforts. Recommendations for the region are outlined below, but are also applicable to other regions of the world.

1. In-Depth Biodiversity Study:

- Conduct comprehensive studies of the flora and fauna in Central Asia, focusing on both species-level and ecosystem-level assessments.
- Utilize modern methods of flora inventory, including digital platforms like iNaturalist and GBIF to create extensive databases.
- Support expeditions to identify and monitor threatened species and model their distribution.

2. Threat Assessment and Reduction:

- Assess threats to vegetation cover at various scales, identifying their causes and dynamics.
- Develop proposals for reducing, mitigating, and ultimately ceasing these threats, seeking official adoption at national and regional levels.
- Monitor the relationship between threats and the provision of ecosystem services crucial for sustainable development.

3. Data Digitization and Publication:

- Accelerate the digitization of herbarium collections in the region and publish this data on global platforms like the Global Biodiversity Information Facility (GBIF).
- Train staff from botanical organizations and universities to meet international standards for data publication.
- Encourage data publication in the form of self-publications (data papers) to improve accessibility.

4. Assessment of Species Extinction Risk:

- Systematically assess the region's flora according to IUCN Red List criteria to determine extinction risk.
- Adopt IUCN standards for species risk assessment as official national and regional standards.
- Update national plant Red Lists and Red Data Books using IUCN criteria, including lists of protected plant species at regional levels.

Due to the construction of the Kapchagai reservoir and climate change, the area of *Populus pruinosa* (NT, IUCN) communities confined to floodplain and coastal areas has strongly decreased in recent years.

In the months of April and May, the vibrant Red goat-grass (*Tragopogon ruber*) adorns the rocky, arid landscapes that span across the diverse regions of Kazakhstan.

5. Protection of Plant Communities *in situ*:

- Implement national programs for maintaining inventories of plant communities and identifying Important Plant Areas (IPAs) based on updated criteria.
- Prepare national lists of rare and protected plant communities.
- Develop a Central Asian Habitat System (biotopes, ecosystems) as a basis for the Red List of Central Asian ecosystems.

6. Reintroduction of Threatened Species:

- Establish and develop existing seed banks for threatened species within botanical organizations.
- Implement a *quasi in situ* approach, which involves selecting species for reintroduction, modeling distribution areas based on bioclimatic parameters, and selecting suitable restoration sites.
- Use existing protected areas, such as nature reserves and national parks, as testing grounds for ecological restoration projects.

7. Legislative and Policy Enhancements:

- Update the terminology in national legislation to align with climate-resilient development and sustainable environmental management.
- Harmonize regional biodiversity terminology with international conventions.
- Develop mechanisms for assessing the economic value of biodiversity and ecosystem services.
- Enhance public participation in environmental activities and promote good governance principles.

8. Public Awareness and Education:

- Foster scientific communication with the public to convey the importance of biodiversity conservation and the appeal of botany as a science.
- Develop educational programs to combat "plant blindness" and raise awareness through lectures, science festivals, and other events.
- Introduce courses on conservation biology and restoration ecology in university education and engage with journalists to promote conservation efforts.

9. International Collaboration:

- Propose projects to international partners to address priority areas of biodiversity protection and vegetation study.
- Invite foreign specialists to collaborate and offer methodological and review courses.
- Actively participate in international biodiversity conferences and expand engagement with current partners.

10. Sustainability of Conservation Efforts:

- Seek and secure funding for biodiversity protection initiatives.
- Establish conservation units within botanical organizations to focus on conservation and restoration.
- Consider forming public foundations (NGOs) to support conservation and environmental education.
- Recognize principles of good governance in biodiversity efforts, as proposed by the OECD.

These measures collectively aim to address the complex challenges facing biodiversity and vegetation conservation in Central Asia, and thus contributing to the GBF targets. This articles emphasises the need for a holistic, region-specific approach.

Photographs by Vladimir Epiktetov and Alexander Dubynin.

Tulipa regelii (Vladimir Epiktetov)

The foundation for appraising the significance of areas for plant conservation lies in the Important Plant Area criteria (as per GBF Target 2). An IPA has been assigned in the Kurty River valley with the objective of safeguarding petrophytic shrub communities featuring *Tulipa regelii*, an endemic species of Kazakhstan.

Incarvillea semiretschenskia (Vladimir Epiktetov)

Limestone mining in Kazakhstan has the potential to result in the eradication of highly restricted endemics, such as Niedzwedzkia (*Incarvillea semiretschenskia*). A crucial aspect of GBF involves encouraging businesses to adopt greater environmental responsibility concerning plant diversity, and to strengthen enforcement of environmental legislation. With the backing of BGCI, the Institute of Botany and Phytointroduction in Almaty has initiated a pilot project to ascertain the status of the species based on IUCN criteria and to determine the conditions for conserving the habitat of this particular species.

Alexander Dubynin and Gulnara Sitpayeva, Institute of Botany and Phytointroduction (Almaty, Kazakhstan)

Author: Maria Paula Contreras

In full bloom, the threatened native species *Pterocarpus acapulcensis*. (Sofia Lissbrant)

AN EXPLORATION OF ORNAMENTAL POTENTIAL OF NATIVE PLANTS IN THE COLOMBIAN CARIBBEAN FOR URBAN LANDSCAPING

In the last decades, the expansion of urban areas has prompted their recognition as playing an essential role in a scenario of climate change and biodiversity loss. Landscaping initiatives that use native plants have the potential to sustain local wildlife by providing food, shelter, and breeding grounds. Additionally, they may help in the creation of biodiverse hotspots and the development of a sustainable gardening approach. The use of native plants with ornamental potential was explored in the Colombian Caribbean considering their conservation importance. I present here the Cartagena Botanical Garden's approach to assessment and prioritization of native plant species with ornamental potential for their use in tropical lowland urban settings.

Introduction

Plant conservation in urban and semi-urban landscapes has become essential in the context of climate change and biodiversity loss. Nations must identify and implement measures to conserve their declining native species, ensuring the preservation of unique ecosystem functions and services, as well as global biodiversity (Segar et al., 2022).

Ornamental plants have recently garnered attention for their potential to improve the quality of the environment and human life amidst the current ecological crisis. Therefore, it has been suggested that, in addition to their aesthetic value, ornamental plants may be used to rehabilitate degraded landscapes, prevent erosion, and manage pollution in urban environments (Toscano et al., 2019)

Recent trends in the transition to native gardening consider gardens as biodiverse hotspots and prioritize sustainable gardening practices, such as water-wise gardening, reducing fossil-fuel energy use, composting gardening waste, and selecting the right plants (MBG, 2022). Scientists, decision-makers, and international conservation organizations acknowledge that sustainable landscapes can mitigate the adverse effects of human activity by promoting a healthier, more resilient ecosystem (Goddard et al., 2013). This is evidenced in the Kunming-Montreal Global Biodiversity framework (GBF) adopted in December 2022, where specific targets were identified focusing on native plant conservation and use in restoration and urban green landscaping.

Additionally, native gardening initiatives become a key component in developing strategies for recovering cities' biodiversity and may play a crucial role in ex-situ conservation of threatened plant species.

Colombian Caribbean

The Colombian Caribbean region boasts a diverse array of native flora species suitable for ornamental use in urban landscaping. These plants have adapted to the region's seasonality and warm, humid climate, with some thriving in various soil types. The harsh climatic conditions have given rise to unique biodiversity that can withstand extreme fluctuations in rainfall. The local vegetation includes deciduous and evergreen trees and shrubs, climbers, herbs, and cacti. Adaptations of these plants include leaf shedding, deep roots, photosynthetic barks, water storage tissues, and a waxy layer on the leaves. Many of these native plants showcase stunning, profuse blooming and intriguing barks.

Plectrocarpa arborea (Maria Paula Contreras)

Introducing native plants into urban settings in the Colombian Caribbean is a winding and challenging road. There exists a significant gap in incorporating native plant species into landscaping in this region. The Cartagena Botanical Garden (CBG), the foremost local institution for research and education in biodiversity conservation, is exploring the ornamental potential of native plants for urban use (Target 12 of the GBF). This initiative aligns with the three dimensions of the GBF: environmental, social, and economic.

- Environmental: The focus is on the conservation of native plants, particularly endangered and endemic species, nature-based solutions, and the promotion of ecosystem services in cities- Targets 2, 4, 7, 8 and 12.
- Social: The initiative involves community engagement through education and outreach for people of all ages, inspiring and enhancing ecological thinking as a collective endeavour- Targets 12, 14, 16, 20 and 21.
- Economic: It operates on two fronts—introducing cost-effective planting of native plants and providing grassroots communities with guidance to generate additional income through these initiatives- Targets 3, 4, 15 and 19.

Gustavia superba (Maria Paula Contreras)

Pterocarpus acapulcensis (Maria Paula Contreras)

Challenges

Urban environments pose significant challenges for restoring biological diversity. The development of urban areas often results in the reduction of natural coverage, habitat fragmentation, diminished plant species diversity, and a decline in pollinator availability. It also leads to the homogenization of habitats, restricting gene flow between populations and increasing the edge effect (Blanco-Libreros & Ramírez-Ruiz, 2021; Ruas et al., 2022). Moreover, natural systems in urban contexts are typically severely compromised, with poor soil structure, inadequate soil aeration, and limited nutrient availability (Bartens et al., 2008). Additionally, urban areas experience higher temperatures than natural landscapes due to the urban heat island effect, which not only has public health implications but may also impede the adaptation of certain plant species.

On another note, natural landscapes are not always perceived as aesthetically pleasing. Alternative landscape designs may face resistance or lack support if they fail to meet people's expectations of beauty. Studies on public perception of native flora indicate that individuals without specialized expertise or interest in native plants may find foreign ecosystems perplexing. Furthermore, the limited incorporation of native plants is often a consequence of industry availability constraints (Tangren & Toth, 2020).

Opportunities

Urban ecosystems can play a fundamental role in the conservation of threatened species, potentially hosting even more biodiversity than nearby natural areas (Callaghan et al., 2020). Cities may represent the last refuge for threatened species, offering a final opportunity to prevent their extinction. The widespread adoption of conservation gardening in all urban green spaces (Target 12) can serve as a community-based approach to safeguarding native species. The integration of native plants into urban areas not only offers educational opportunities for community members but also imparts knowledge about the importance of local ecosystems and biodiversity. Studies have demonstrated that raising awareness of the value of native biodiversity in gardens can influence people's attitudes, values, and behaviors in favor of native gardening. Furthermore, the incorporation of green infrastructure can enhance human thermal comfort indoors and during construction, reducing energy needs (REF?). It also contributes to re-establishing valuable ecosystem services, including shade, evaporative cooling, and the regulation of soil processes (Ghafarian et al., 2022).

Plant material collection from the wild. (Tomás Pinzón)

Cartagena Botanical Garden team in field trip collecting seeds of native plants (Olivia Lockyear)

"The Colombian Caribbean region has diverse native plant species that can be used as ornamentals in urban landscaping."

The role of the Cartagena Botanical Garden

The science and horticulture teams at the Cartagena Botanical Garden (CBG) are collaboratively working to comprehend and domesticate native plants for their integration into urban settings. This involves actions such as phenological analysis, propagation protocols, educational programs, and the evaluation of life cycles and growing rates. In this regard, the CBG plays a crucial role in providing commercial nurseries with first-hand access to knowledge and practical assistance. The role of nurseries is essential for implementing native gardening in urban settings; without available plants, this would not be feasible. Furthermore, it has never been more important to establish specialized nurseries that produce native trees, ensuring a germplasm source and genetic diversity. While the industry manages to maintain an available stock of native plants, the CBG is developing a strategy to promote the advantages of adopting native plants and their implications with landscape architects and communities, encouraging their use once available.

Pelliciera rhizophorae (Maria Paula Contreras)

To identify candidate species, a gap analysis was conducted, considering factors such as IUCN Red List conservation status, life cycle, foliage permanence, salt tolerance, wind resistance, and previously reported landscape use. Out of 369 species, 39 were prioritized as target species for the Colombian Caribbean region based on the final score (see Table 1). In the face of unstoppable urban development, this result provides an opportunity to channel efforts toward plant conservation with an ornamental approach in urban environments, defining cities as biodiverse, sustainable, and resilient areas by promoting a botanical focus and inline with Target 13 on Access and benefit-sharing for plat conservation.

Native plants propagation at the Cartagena Botanical Garden, Research nursery. (John Bernal)

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Seed collecting, threaten and endemic to Colombia species *Clavija sanctae-martae*. (Maria Paula Contreras)

Scientific name	Plant habit	Redlist category	Profuse blooming	Life cycle	Foliage	Reported landscape use	Wind resistance	Salt tolerance
Guaiacum officinale	Tree	EN	Y	PE	EV	Y	M	H
Pterocarpus officinalis	Tree	NT	Y	PE	DE	N	H	H
Talinum paniculatum	Herb	NE	Y	PE	EV	Y	M	H
Aspidosperma polyneuron	Tree	EN	N	PE	EV	N	M	L
Bactris guineensis	Palm	NE	N	PE	EV	Y	H	M
Libidibia punctata	Tree	VU	N	PE	DE	Y	M	M
Pachira quinata	Tree	VU	N	PE	DE	Y	H	H
Pelliciera rhizophorae	Tree	VU	N	PE	EV	N	H	H
Plectrocarpa arborea	Tree	NE	Y	PE	EV	Y	M	M
Tribulus cistoides	Herb	NE	Y	PE	EV	Y	H	H
Bucida buceras	Tree	NE	N	PE	EV	Y	H	H
Cedrela odorata	Tree	VU	N	PE	DE	Y	M	L
Chrysobalanus icaco	Shrub	LC	N	PE	EV	Y	H	H
Coccoloba uvifera	Tree	LC	N	PE	EV	Y	H	H
Combretum fruticosum	Vine	NE	Y	PE	EV	Y	H	M
Evolvulus convolvuloides	Herb	NE	Y	PE	EV	N	H	H
Haematoxylum brasiletto	Tree	LC	Y	PE	DE	Y	H	H
Heliotropium curassavicum	Herb	LC	N	PE	EV	Y	H	H
Hymenocallis littoralis	Herb	NE	Y	PE	DE	Y	H	H
Ipomoea pes-caprae	Herb	LC	Y	PE	EV	Y	H	H
Jatropha integerrima	Shrub	NE	Y	PE	EV	Y	H	M
Malpighia glabra	Shrub	LC	N	PE	EV	Y	H	H
Manilkara zapota	Tree	LC	N	PE	EV	Y	H	H
Melicoccus oliviformis	Tree	NE	N	PE	EV	Y	M	M
Platymiscium pinnatum	Tree	NE	Y	PE	DE	Y	M	M
Pterocarpus acapulcensis	Tree	VU	N	PE	DE	N	M	M
Avicennia germinans	Tree	LC	N	PE	EV	N	H	H
Bignonia diversifolia	Vine	NE	Y	PE	EV	Y	M	M
Cecropia longipes	Tree	EN	N	PE	DE	N	L	M
Erythroxylum carthagenense	Tree	NE	N	PE	EV	Y	H	M
Gustavia superba	Shrub	LC	Y	PE	EV	Y	M	M
Handroanthus billbergii	Tree	NE	Y	PE	DE	Y	M	L
Melicoccus bijugatus	Tree	LC	N	PE	DE	Y	H	H
Passiflora foetida	Vine	NE	Y	PE	EV	N	M	M
Petrea volubilis	Shrub	NE	Y	PE	DE	Y	H	M
Quadrella odoratissima	Tree	LC	N	PE	EV	Y	M	H
Rhizophora mangle	Tree	LC	N	PE	EV	N	H	H
Sapindus saponaria	Tree	LC	Y	PE	EV	N	H	M
Tecoma stans	Shrub	LC	Y	PE	EV	Y	M	M

Target native species with ornamental potential. EN: Endangered, VU: Vulnerable, NT: Nearly threatened, NE: not evaluated, LC: Least Concern, Y: Yes, N: No, EV: Evergreen, DE: Deciduous, H: High, M: Medium, L: Low, PE: Perennial

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Plant people on excursion, Nötholmen Vrångö. (Travis Þrymr Heafield)

COLLABORATION FOR CONSERVATION IN THE NORDIC NETWORK OF BOTANIC GARDENS TOWARDS THE GLOBAL BIODIVERSITY FRAMEWORK

Botanic gardens in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have recently started a collaboration. The aim of the network is to strengthen conservation work by collaboration across borders, and together influence policymakers on biodiversity and conservation issues. The first meeting was held in Gothenburg in October 2023.

During the European Botanic Gardens Congress (EuroGard IX) in Budapest 2022 the idea of a Nordic network of botanic gardens began to form to work together to achieve local, regional and international conservation targets, such as those of the Convention on Biological Diversity (CBD) Global Biodiversity Framework (GBF). After a few online meetings the first physical meeting took place in Gothenburg Botanical Garden in October 2023. A total of 28 participants representing the majority of botanic gardens in Denmark, Iceland, Norway and Sweden got together during two rainy days at the Swedish west coast.

Initially all gardens shared experiences and challenges and got to know each other's collections a bit better. There was a high sense of recognition and easy to find common issues. In no time, several overlapping interests were identified and the discussions started right away! What plant labeling systems are we using in the different gardens? Could we share exhibitions? How do we organize work exchanges? How do we communicate what a botanic garden is? How should we communicate the conservation work done in botanic gardens to politicians?

Nordic network meeting inside (Kristina Bjureke)

Arriving at Nötholmen Vrångö. (Mats Havström)

A collaboration between the Nordic countries seems only natural since the flora is rather similar and many endangered species are distributed across country borders. During this first meeting one of the main topics was therefore to exchange experiences from integrated conservation projects in the different Nordic countries. How are conservation projects *in situ* and *ex situ* combined? How can the botanic gardens collaborate and learn from each other?

"The aim of the network is to strengthen conservation work by collaboration across borders, and together influence policymakers on biodiversity and conservation issues."

At Vrångö, an island in the archipelago just outside Gothenburg, there is an ongoing integrated conservation project focusing on sea holly, *Eryngium maritimum*. The thorny species of Apiaceae is red listed in Denmark, Norway and Sweden, and in Norway and Sweden there are existing reintroduction projects involving the botanic gardens. Vrångö was a good place to continue the constructive discussions from the day before and we managed to get some sun, or perhaps not sun but at least an hour of no rain. We looked at the work that Gothenburg Botanical Garden is doing together with the County Administrative Board of Western Sweden and compared it to a similar project going on in Lund, Sweden. In Gothenburg, the project started in 2015 and since 2016 about 300 plants have been reintroduced in the region each year. The Swedish red list status of *Eryngium maritimum* was in 2020 changed from Endangered(EN) to Vulnerable (VU).

While looking around the site a keen eye caught sight of the first recorded natural seedling in this reintroduction project. A great success both for the project and the meeting! After this excitement a hot meal and a presentation on Norway's current work with *Eryngium maritimum* was on the agenda. We concluded that the projects in Sweden and Norway have a lot in common and that there is a need for someone working on the genetics of the species to investigate biogeography and migration patterns.

Sea holly *Eryngium maritimum* in October, Vrångö. (Stina Weststrand)

Joel Levin from Lund Botanical Garden describes the integrated conservation work done in Skåne, Sweden. (Mats Havström)

A natural seedling of *Eryngium maritimum* at Nötholmen, Vrångö. (Stina Weststrand)

Kristina Bjureke from Oslo Botanical Garden presents the integrated conservation work on *Eryngium maritimum* in Norway. (Stina Weststrand)

Another common interest for the Nordic network is seed banking of wild plants (GBF Target 4), since the existing joint setup for seed banking in the Nordic countries focuses on crops and crop wild relatives (CWR (GBF Target 4, 9 & 10). Together we discussed how to best collaborate, apply for funding and what a stable infrastructure would look like. Some smaller seed banks already exist at a few of the gardens, but we all see the benefits of a common larger facility accompanied by local seed banks. The invited speaker Hannes Dempewolf, Crop Trust, gave some insights to projects related to CWR.

One thing that was discussed after Hannes' talk was how to move seeds across borders since Norway is not part of the EU, which makes it difficult in for example a conservation project where a species is distributed in both Sweden and Norway and seeds have to be moved between populations in the different countries. This is not unique for the Nordic countries but is a challenge on a global scale as well and is very important as access and benefit-sharing of genetic resources needs to be taken into consideration (GBF Target 13). What we need is to develop new and stable solutions to collaborate and to exchange plant material in a fair and equitable way.

"The general consensus is that if we work together and share both material and experiences we can make a greater impact."

The importance of getting to know each other and addressing barriers to future collaboration and work exchange permeated the meeting. The Nordic countries have quite a few botanic gardens, but they are small institutions. One of the major challenges that most of the gardens shared was time, or rather, lack thereof. The consensus was that if we work together and share both material and experiences, we can make a greater impact towards individual gardens goals but also the GBF Targets. This will in turn enable us as botanic gardens to influence policy-makers on biodiversity and conservation issues. Next steps are to formalize the network and construct a structure for joint projects and engage all professions at the gardens in the network. The next physical meeting will be held in Oslo, Norway and until then a few subgroups will keep working on seed banking and the integrated conservation projects.

The meeting was financed by SLU Swedish Species Information Centre through their funds for networking activities.

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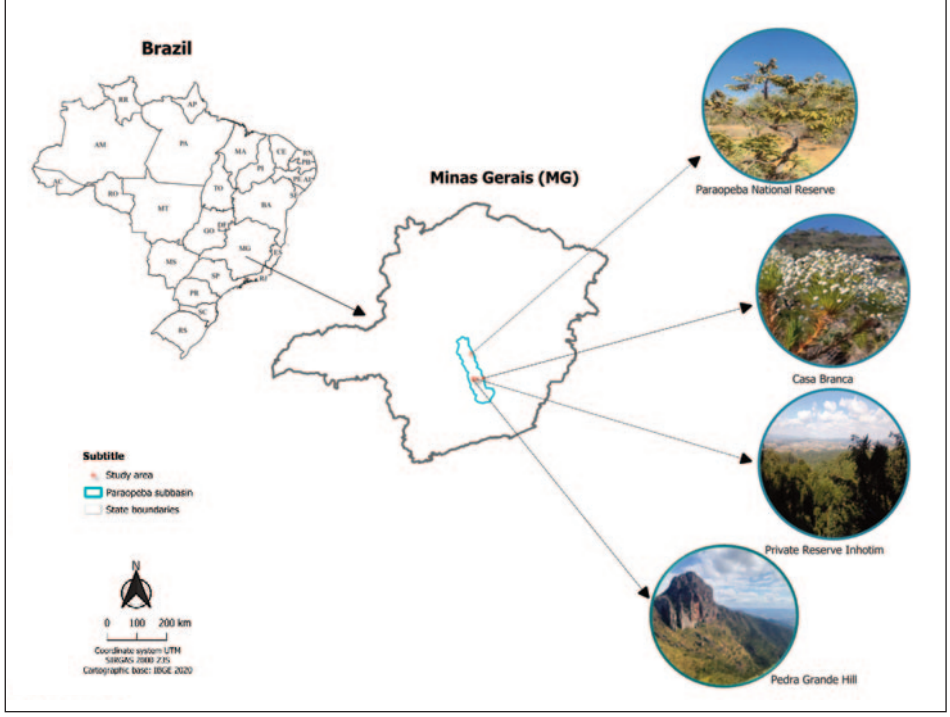
CULTIVATING ECOSYSTEMS: INVESTIGATING THE PROPAGATION OF NATIVE SPECIES IN BIODIVERSITY HOTSPOTS

Botanical Expedition in the Casa Branca region

Botanical gardens can collectively advance conservation efforts by sharing knowledge. Cultivating Ecosystems is an initiative of the Instituto Inhotim, expands the current understanding of lesser-studied plant species and their propagation methods but also provides data for the restoration of threatened ecosystems. The initiative aims to promote the sustainable use of biodiversity according to global initiatives for ecosystem restoration and biodiversity which call for global action. Significant progress has been made since its inception where 10 expeditions and 12 experiments have been conducted.

Introduction

The pressing need for transformative change has become evident in the face of the ongoing extinction crisis of global species, predominantly propelled by human-driven and concurrent climate crises. This change, embodied in the concept of sustainable development, necessitates an overhaul of resource utilization practices, production methods, and consumption patterns. Conservation and restoration efforts play a pivotal role in tackling both biodiversity and climate crises, seamlessly aligning with the vision and mission outlined in the Kunming-Montreal Global Biodiversity Framework. Natural landscapes act as carbon buffers, whereas restored areas serve as effective carbon sinks, which help in mitigating atmospheric CO_2 levels. Conservation and restoration have emerged as potent strategies to address the complex challenges posed by these global crises (Bustamante et al. 2019).



Map of the areas of the botanical expeditions. The Instituto Inhtotim and the natural areas are located within the Paraopeba sub-basin in the state of Minas Gerais, southeast of Brazil. Pictures: Elisangela Costa and Nayara Mota.

Nevertheless, both require specialized approaches grounded in a comprehensive understanding of the species involved. Likewise, enhancing cultivation techniques and promoting native species for sustainable use require scientific research, which serves as a critical element for addressing environmental crises. The UN Decade on Ecosystem Restoration underscores the need to develop knowledge on sustainable biodiversity management.

Considering Brazil's status as one of the world's most biodiverse countries, the sustainable management of Brazilian biodiversity is imperative. The list of angiosperms in Brazil includes 35,920 registered species (REFLORA, 2023), with discoveries still ongoing. Managing this diversity is challenging, with 3,209 species currently at risk of extinction (MMA, 2022), including newly discovered species. Just one lost species may represent a missed opportunity, as several Brazilian species have the potential for sustainable use.

However, significant gaps in scientific knowledge persist, such as native plant propagation. The government's commitment to restoring 12.5 million hectares further emphasizes the need for research in these areas. Brazil cannot afford to neglect basic research considering the critical need to study and understand its vast biodiversity. Basic plant research, including that on the production of native species, is paramount (Pinã-Rodrigues et al., 2018). Challenges such as limited germination databases, insufficient cultivation knowledge, and prevailing misconceptions about native plant propagation, underscore the urgent need for improved understanding and utilization of the native flora. This shift is gradually taking shape, and institutions are striving to contribute to this transformation. Botanical gardens must be at the forefront of overcoming these challenges, contributing to the necessary knowledge, and striving to maintain a relevant botanical collection for conservation and restoration.

This project aimed to develop propagation techniques for lesser-studied plant species. Located in a region of ecological significance where the Atlantic Forest, Cerrado, and Rupestrian Grasslands converge, the Instituto Inhotim recognizes the urgency of cultivating these species for conservation, restoration, landscaping, and educational purposes. This initiative seeks to enhance the knowledge of seed collection, storage, germination, and cultivation for species with limited propagation data. The study additionally sought to enhance the collection by collecting propagules from the natural areas in the region. The goal is to fill the knowledge gaps on species while appreciating the local biodiversity in our botanical collection.

Botanical expeditions

The project comprised 10 botanical expeditions completed at four different sites located southeast of Brazil, close to the Inhotim Institute (Minas Gerais State). Here, four expeditions were carried out in the Private Reserve Inhotim (20°07'S 44°14'W), three in the Paraopeba National Reserve (19°16'S 44°23'W), two in the region of Casa Branca (20°05'S 44°01'W), and one close to the Pedra Grande Hill (20°7'S 44°21'W). These areas are situated in a diverse environmental context within a transitional area between the Cerrado and Atlantic Forest, two biodiversity hotspots characterized by high richness, endemism, and susceptibility to anthropogenic activities. Furthermore, the region is located in the southern part of the Espinhaço Range, featuring rocky outcrops and highly diverse plant species (Rupestrian Grassland). Threats to these environments include mining exploration and the expansion of real estate.

"In the face of insufficient Brazilian plant propagation knowledge, Botanical Gardens can spearhead a transformative shift, actively contributing to the enhanced understanding, utilization, and conservation of native flora."
Nayara Mesquita Mota

Collection of propagules

All the collected material was for seedling production, testing for germination, storage in a seed bank, or to be sown directly in a rainfed garden (one experimental naturalistic garden; Pastore and Honorato, 2023). The final use of each species was determined based on the type of propagule, quantity collected, and information available regarding the species in scientific literature.

Germination tests

When selecting the species for the experiments, species were prioritized that had sufficient propagules for scientific investigation and met the criteria of being threatened with extinction, possessing ornamental characteristics for landscaping, or fulfilling ecological functions for restoration. Twelve experiments were conducted with the application of 16 different protocols following the particularities of each species and Table 1 below.

"Botanical Gardens must strive to maintain a relevant botanical collection for conservation and restoration."
Nayara Mesquita Mota

Table 1. Twelve species germinations tested, and results

Species	Status	Habitat	Germination test	Results
Syagrus deflexa Noblick & Lorenzi	VU	This palm is endemic to the Cerrado (REFLORA, 2023).	To evaluate the germination in two substrates—Carolina Soil® and Germitest Paper	Faster germination in Carolina Soil than in Germitest Paper.
Syagrus macrocarpa Barb. Rodr	EN	This rare palm has a restricted distribution in the Atlantic Forest (REFLORA, 2023).	Treated with 4 concentrations of gibberellic acid for 48 h and sown in zipped plastic bags containing the Carolina Soil® substrate.	The use of gibberellin did not influence germination.
Syagrus botryophora (Mart.) Mart.	VU	This palm is endemic to the Atlantic Forest (REFLORA, 2023).	Mechanical scarification (emery) & gibberellic acid (400 and 800 ppm) for 24 hrs in two substrates (Carolina Soil® and Germitest Paper). Ebryo vigor & propagule condition were assessed in two maternal plants using tetrazolium and X-ray tests.	Pending
Syagrus ruschiana (Bondar) Glassman	VU	Palm endemic to Brazil, occurring in rock outcrops in the Atlantic Forest and Cerrado (REFLORA, 2023).	Three types of storage are being evaluated: 1. cold chamber (5°C) 2. room temperature (approximately 25°C) 3. cold chamber (5°C) All checked at periods of 0, 15, 30, 60, and 120 days.	Pending
Syagrus glaucescens Glaz. ex Becc	LC	Palm endemic to Brazil, occurring in rock outcrops in the Atlantic Forest and Cerrado (REFLORA, 2023).	Three types of storage are being evaluated: 4. cold chamber (5°C) 5. room temperature (approximately 25°C) 6. cold chamber (5°C) All checked at periods of 0, 15, 30, 60, and 120 days.	Pending
Psidium rufum Mart. ex DC.	LC	Tree endemic to Brazil and a zoochoric species of the Atlantic Forest and Cerrado.	Mechanical (sandpaper) and thermal (70°C water for 5 min.) scarification on two substrates (Carolina Soil® and Germitest Paper).	Scarification did not enhance the germination. Higher germination rates were observed when associated with the Carolina Soil® substrate.
Mollinedia widgrenii A. DC.	NE	Tree endemic to Brazil and are zoochoric species of the Atlantic Forest and Cerrado.	Mechanical (sandpaper) and thermal (70°C water for 5 min.) scarification on two substrates (Carolina Soil® and Germitest Paper).	Scarification did not enhance the germination. Higher germination rates were observed when associated with the Carolina Soil® substrate.

Species	Status	Habitat	Germination test	Results
Schefflera macrocarpa (Cham. & Schltdl.) Frodin	NE	Tree endemic to Brazil and are zoochoric species of the Atlantic Forest and Cerrado.	Mechanical (sandpaper) and thermal (70°C water for 5 min.) scarification on two substrates (Carolina Soil® and Germitest Paper).	No germination was observed for the seeds
Sesbania virgata (.) Poir.	NE	Zoochore in the Cerrado region	Mechanical scarification (sandpaper) & thermal scarification (70°C water for 5 min) at two environmental temperatures—25°C and 30°C.	Mechanical scarification was more efficient, achieving greater & faster germination in regardless of the environmental temperature.
Enterolobium gummiferum (Mart.) J. F. Macbr. v	LC	Zoochore in the Cerrado region	Mechanical scarification (sandpaper) & thermal scarification (70°C water for 5 min) at two environmental temperatures—25°C and 30°C.	Mechanical scarification was more efficient, achieving greater & faster germination in regardless of the environmental temperature.

Fruit Screening

Seedling production, seed bank, and direct sowing

Various propagation methods were strategically employed for the other collected propagules to achieve zero losses in collections, including cutting and traditional techniques. Large quantities of orthodox seeds (>300 seeds) were designated for storage in a seed bank, whereas recalcitrant seeds or those collected in smaller quantities were earmarked for seedling production. Presently, 676 seedlings have been produced from seeds and 65 from cuttings. These seedlings will be planted within Inhotim gardens, contributing to the botanical collection, or may be donated to external institutions. Seeds of annual species will undergo direct soil sowing in rainfed gardens.

Scientific Dissemination

Scientific dissemination of the results obtained is a crucial component in consolidating the relevance of the project. In this context, the *Cultivating Ecosystems Seminar* was part of the 20th National Science and Technology Week. This event provided the opportunity to present the results achieved and served as an enriching moment for external speakers whose research addresses topics such as biodiversity conservation, tackling climate change, the production of renewable energy, and sustainability. Within a week, two behind-the-scenes visits to the project were conducted, providing a detailed view of the experiments and their relevance, difficulties faced, and solutions. Additionally, three abstracts from the experiments were presented during two external scientific events. This represents a valuable opportunity to share knowledge and experience with other professionals, researchers, and scientists. Furthermore, this will significantly contribute to the dissemination of essential information on conservation horticulture, an essential part of implementing the GSPC Complementary Actions of the GBF, which is the core of this project.

Above and top: Assembly of Germination Experiment

"The restoration of complex and diverse landscapes that are under different pressures is a challenge that demands new approaches of environmental governance. It also demands additional investment for the development of restoration science and technologies, and continued actions for training and technical assistance in environmental compliance and sustainable use of the landscape. Furthermore, there are numerous Brazilian species that have high potential for sustainable use but are still understudied."
Bustamante et al. 2019.

Conclusion

The Cultivating Ecosystems Project was initiated to gain an understanding of the local flora and contribute to the knowledge and utilization of these species. In a brief period, expeditions were successfully organized, propagules were collected, three studies were published in conference proceedings, with a scientific paper is currently ongoing. Accelerating the germination of some of the collected species has proven challenging and requires prolonged maintenance under optimal conditions. This, however, remains a problem that must be addressed. The study faced other challenges such as species identification, some remaining, and insufficient propagules for germination tests. Nevertheless, the initial expansion of the efforts in propagation studies strengthens the commitment to continue progressing in this direction.

Concluding remarks

Botanical gardens are encouraged to further investigate the native flora of their respective locations, especially in areas where little is known about the flora. Additionally, the cultivation of these species within the botanical gardens is recommended. Several of these species remain underutilized because of the lack of propagules and propagation studies, a gap that botanical gardens can bridge by organizing collection expeditions, conducting scientific experiments, and disseminating the results. This study has demonstrated the value of undertaking such initiatives, and it is hoped that similar activities will become regular practices in botanical gardens. In Brazil and other tropical regions characterized by high biodiversity and limited financial resources, it is imperative for botanical gardens to focus on understanding regional flora and to showcase these plants to the public.

Above and below: Cultivating Ecosystems Seminar.

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RESCUE AND CONSERVATION OF THREATENED ENDEMIC SPECIES IN THE BOTANICAL GARDEN CUPAYNICÚ

Summary

The loss of endemic species causes irreparable damage to natural areas, which is why it merits any effort aimed at its recovery. The activities carried out in the Cupaynicú Botanical Garden are aimed at the conservation and propagation of six endemic species of the Granma province. Five of them categorized as Critically Endangered (*Crotalaria ekmanii*, *Begoniia cowellii*, *Piper baracoanum*, *Coccothrinax victorinii*, *Annona cubensis*), and Eugenia aceitillo as Vulnerable. To achieve this the floristic inventories of vascular plants of 11 protected areas were updated alongside the cultivation of these important Cuban species.

Introduction

The Cupaynicú Botanical Garden of Granma (JBC) was created during the Cuban Revolution to offer the people a recreational space, while also serving to raise the cultural and scientific-research level of the citizens and develop in them a better understanding of environmentalist. Situated in the foothills karst of the Sierra Maestra, in the Guisa municipality, it has an area of 105 hectares, mostly covered with forests that make up the Managed Floristic Reserve "Monte Natural Cupaynicú" (CPY), the garden also has an area dedicated to the threatened endemic species and another for gardening, a rockery and a solarium, a pavilion and three shadehouses for ornamental shade plants. The collections consist of medicinal plants, fruit trees, palms, and exotic trees. A professional team carries out research in the fields of botany, ecology and environmental conservation.

Adult individual of *Coccothrinax victorinii* preserved *ex situ* in the Cupaynicú Botanical Garden.

Crotalaria ekmanii specimen

Specimen of Begonia cowellii

In an attempt to stop the loss of existing floristic resources in the Cuban archipelago (Paulay 1994), which hosts approximately 7 000 to 7 500 plant species (Borhidi 1996, Berazaìn et al. 2005 and Gonzales-Torres et al. 2016), one of the main tasks of Cupaynicú Botanical Garden is the rescue and conservation of biodiversity. The Cupaynicú Botanical Garden arranged the collection of endemic species exclusive to the Granma province, under extreme threat, to cultivate them ex *situ* and subsequently reintegrate them into their natural environment. This work adresses several taregts of the Conventun on Biological Diversity, Kunming-Montreal Global Biodiversity Framework (GBF), namely Targets 1 (Plan and Manage all Areas To Reduce Biodiversity Loss), 3 (Conserve 30% of Land, Waters and Seas), 4 (Halt Species Extinction, Protect Genetic Diversity, and Manage Human-Wildlife Conflicts) and 22 (Ensure Participation in Decision-Making and Access to Justice and Information Related to Biodiversity for all).

In order to locate the species that grow in the Granma province, the species lists of vascular plants of the protected areas were reviewed and updated. This included the National Parks: “Desembarco del Granma” (GRA), “Pico Bayamesa” (BAY) and “Turquino” (TUR), Ecological Reserves: “El Gigante” (GIG), “Pico Caracas” (REC), “El Macío” (EMC), Wildlife Refuges: “Delta del Cauto” (CAU), “Monte Palmarito” (PAL), “Ensenada de Gua y Cayos de Manzanillo” (MAN) and Managed Floristic Reserve “Monte Natural Cupaynicú” (CPY). In total of the indigenous species of flowering vascular plants that grow in the Granma province, we found 2 318 species, of which 545 are endemic. The species inventoried for Granma were added to the updated inventory of vascular plants of Cuba (Greuter & Rankin 2022), the inventory of lycophytes and ferns of Cuba (Sánchez 2021), as well as the taxa that appear in sections of the Flora of the Republic of Cuba (1998-2022). This work contributes to the GBF Targets 1 and 3. The red lists of the Cuban vascular flora were reviewed to determine the latest threat categories (Berazaín et al. 2005 & González-Torres et al. 2016), thus workign towards Target 4 of the GBF.

Five endemic species categorized Extinct (EX) or Critically Endangered (CR) were collected, these included: *Crotalaria ekmanii*, *Begoniia cowellii*, *Piper baracoanum*, *Coccothrinax victorinii*, *Annona cubensis* (recently categorized as Critically Endangered CR) and *Eugenia aceitillo*, as its recovery is of interest, although it is only categorized as Vulnerable (VU). Our work in this area mainly contributes to Target 4 of the GBF working on preventing extinctions of species and conservating them ex *situ* and *in situ* where possible. Throughout the work of the Cupaynicú Botanical Garden we adhere to Target 22 ensuring participation by all.

Crotalaria ekmanii (Figure 1D), only occurs in the Río Cauto municipality, close to the banks of the river that has the same name. In addition to the type specimens, only the collections of Ekman between 1914 and 1917, Urban 1928, Senn 1939, Acuña and Pujols 1954 were known. Thirty-seven years later, in 1991, it was rediscovered by an expedition sponsored by the Cupaynicú Botanical Garden, made up of Ángela Leyva and Andrés López-Martel; later, in 2006, it was collected by Rosa M. Labaút López, in another botanical expedition from the Cupaynicú Botanical Garden. The seed of specimens of this last collection is kept cultivated in the nursery and the Endangered Plant Area, as well as in other botanical gardens and by hobbyists. It was also the focus of a Masters thesis carried out and directed by specialists from the garden and the Agroforestry Experimental Station of Guise.

Begonia cowellii (Figure 2A), was discovered in 1912, in Ensenada de Mora, municipality of Pilón, south of Naguas and Caridad de Mota. It was collected by Ekman in 1922 near the Bayajá stream, south of Nagua, Bartolomé Masó municipality and Alaín and Crysogono, collected it in Caridad de Mota, Pilón in 1949. At the end of the 20th century it was already considered Extinct (Berazaín 2009), however, an expedition carried out by Salvador Arjona, accompanied by members of the amateur club “Friends of the Cupaynicú Botanical Garden”, in 2014, found it again in Puriales de Jibacoa, municipality Bartolomé Masó (González-Torres et al. 2013). Since then, visits have been made to this town, and guidenace provided to the owner of the property for its preservation in situ, in addition, it is cultivated ex *situ* in the shade houses of Cupaynicú and botanical gardens in other provinces (Verdecia 2015). Piper baracoanum (Cuban pepper) (Figure 1C), was thought to occur solely in Baracoa, where it was discovered by Wright in 1861(1861), and was considered Extinct (E) after more than a hundred years without being located again. In 1991, after 130 years, it was rediscovered by R. Verdecia in the Mogote Vegetation Complex, forming part of a thicket on karsified limestone, in El Raudal, on the way to Victorino, Guisa municipality. Since its rediscovery, it has been found that the area of occupation of the population is limited to the top of the mogote adjacent to the primary school in the same town. Collected seeds were germinated ex *situ* and the seedlings distributed among the participants at the meeting of the Cuban Botanical Gardens Network in 2019, others were planted in areas of the garden where they now thrive. Currently, field visits are being carried out to learn more from the original population and it has been found that, although it is a shrub, it is capable of spreading vegetatively.

Piper baracoanum in its new distribution area

The known population of *Coccothrinax victorinii* (victorine palm) (Figure 2B), was initially reduced to its type locality, at the mouth of the Tana River, Media Luna municipality, on sandy soil mixed with humus. Later, other specimens were located along the coast, extending to Punta de Casimba, near Cabo Cruz, in the Niquero municipality, with some individuals grouping together on Carenero beach. Material was collected from adult specimens that grew at the mouth of the Tana River and cultivated in the Media Luna. The two specimens grown in the garden's Endangered Plant Area are currently about 6 m tall and produce fertile fruits, that have a high germination rate given continuous maintenance and attention, although they take 2-3 months to germinate. Currently, the seedlings are grown in bags given their slow growth.

Annona cubensis (wild apple, Roig 1965) (Figure 1A), was described based on a specimen collected by Ekman (1915), in Holguín, Sierra de Nipe, in Loma La Estrella. However, it has not been located again in this province. A second collection at the beginning of the 20th century, carried out by Juan Tomás Roig, lacks locality data and in 1935 Acuña found it in Santiago de Cuba, south of Pico Turquino, in Bella Pluma (current Guamá municipality). It is speculated that this subpopulation could have disappeared during the construction of the highway that connects Santiago de Cuba with Pilón. J. Bisse, at the end of the 20th century, collected it in the semi-deciduous forest of CPY, and as part of the preparation of the 2017-2021 Management Plan for this protected area, it was declared a species of conservation importance as it is a tree species, endemic and a wild relative of important fruit trees. In accordance with this approach, we have worked with community members and garden staff to locate and conserve a greater number of specimens that grow in natural conditions and it is thought that only 50-100 specimens exist. Currently, germination practices are being carried out on the seeds, however, only few have germinated andare destined to reinforce the existing population within the garden, Grafts on Annona montana rootstocks have been successful and an undergraduate thesis titled "Ethnobotanical characterization, phytochemistry and conservation of the big-horn sugar apple (Annona cubensis RE Fries)" was published.

Eugenia aceitillo (Figure 1B), is a threatened species listed as Vulnerable, whose population was restricted to Cabo Cruz, forming part of evergreen and semi-deciduous forests, with no more than 2 000 or 3 000 individuals. Almost coinciding with the inauguration of the botanical garden, two specimens were planted in the Endangered Species Area, which have been fruiting for almost 10 years. The small, sweet fruits have served as food for indigenous birds and bats that disperse them throughout the semi-deciduous forest, with successful germination, leading to the establishment of a subpopulation of about 900 specimens, which ensures the perpetuity of the species.

Conclusions

Among the almost 2 000 species of vascular plants present in the Cupaynicú Botanical Garden, the presence of 102 species of the endemic flora of Cuba is testament to the hard work and dedication of the garden to conserve the natural flora of Cuba. This is an excellent example of how botanic gardens can contribute to both national and international conservation targets. The rescue and propagation of species in serious danger of threat will always have excellent results, as long as it is carried out in a coordinated manner between the technicians and specialists of the protected areas and the Network of Botanical Gardens of Cuba.

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Luis Joaquín Catasús Guerra,
Doctor of Science and Researcher, recently passed away. He was a dedicated Cuban scientist who made significant contributions to the field of agrostology and the taxonomy of Poaceae. His work had a profound impact on the conservation of plant diversity, particularly during his time at the Cupaynicú Botanical Garden, where he worked until his final days.

Annona cubensis flower

Authors: Chu Xiuli, Wei Yukun, Xiao Yuee, Fu Yanru, Zhang Jie, Gu Junzhe, Luo Juan, Yao Enyang and Yan Wei

INTEGRATED CONSERVATION FOR *YULANIA ZENII*, AN ENDEMIC, RARE AND ENDANGERED PLANT SPECIES IN CHINA

Flower buds of *Y. zenii*

Summary

Global climate change and biodiversity loss are the most important ecological and environmental issues facing human survival and development today. The adoption of the Global Biodiversity Framework (GBF) at the convening of the 15th Conference of the Parties to the Convention on Biological Diversity (COP15) has opened a new era of global biodiversity conservation (Xu and Wang, 2023). Botanical gardens are an important biodiversity battlefield, with their core task being the *ex situ* conservation of wild plants through collection and conservation of rare and endangered species. Shanghai Botanical Garden, based in the East China and Yangtze River Delta regions of China, has always attached great importance to the introduction and conservation of plants, especially of the rare and endangered ones. Since its establishment, the garden has collected more than 10000 taxa, including 4500 species and over 6000 varieties. 341 rare and endangered species, belonging to 25 families and 51 genera, have been preserved, including 201 nationally protected wild plants (Wei et al., 2023), with 71 large woody plants such as *Yulania zenii*.

Introduction

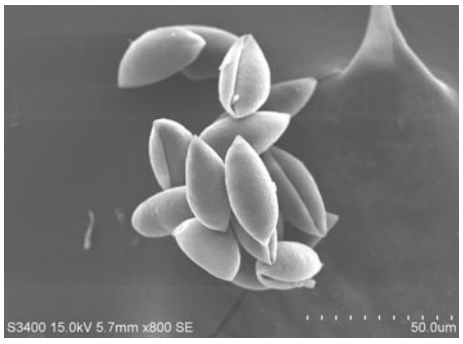
Shanghai Botanical Garden attaches great importance to the *ex situ* introduction of Magnoliaceae plants such as *Y. zenii*. *Yulania zenii* first introduced in 1980, and it was not until 1997 that five *Y. zenii* grafting plants were successfully introduced, which were able to grow normally and already bloom and bear fruit. In order to further promote the *ex situ* protection and reintroduction of the species, Shanghai Botanical Garden, in collaboration with Nanjing Forestry University, Jiangsu Provincial Wildlife Conservation Station, and the Zhenjiang Jurong Baohua Mountain National Forest Park Management Committee, has initiated the tree protection project "Integrated Conservation of China's Rare and Endangered Plant *Yulania zenii*" with Botanic Gardens Conservation International (BGCI). This project aims to establish a demonstration site for reinforcement, whilst enhancing the plant protection awareness and technology of all stakeholders, in order to effectively protect this tree species.

Wild Plants of *Y. zenii*

Y. zenii belongs to genus *Yulania* in Magnoliaceae family and is a precious germplasm resource of ornamental trees. It is the city tree of Jurong City and the sister tree species of *Y. denudata* which is the city flower of Shanghai. *Yulania zenii* produces high quality wood because of its straight trunk and fine wood texture. Flowers, fruits, seeds, and bark are all used in medicine, and have antibacterial and anti-inflammatory properties, with anti-tumour, antispasmodic, and analgesic effects. The petals are edible and rich in nutritional value, and flowers are rich in fragrance and can be used to extract essential oils with high economic and utilization values.

While the distribution of *Y. zenii* is extremely narrow according to early records, only one wild population with 18 mature individuals was found in northern Baohua Valley, in the Baohua Mountain National Forest Park in Jurong City, Jiangsu Province, China. Low reproductive capacity, due to low seed production and germination rates and variable seed production across years results in a poor natural regeneration and limited young trees in the wild. In actioning Target 4 of the GBF *Y. zenii* has been listed as a National Second Grade Endangered Protected Plant in both *China Plant Red Data Book* and *List of National Key Protected Wild Plants in China* (both in the first batch and the 2021 version), and as a Critically Endangered Species (CR) by IUCN *China Red List of Red Plants*, *China Biodiversity Red List-Higher Plant Volume* in 2013, and List of Threatened Species of Higher Plants in China in 2017. Conservation efforts have been limited, and there is an urgent need to develop conservation strategies to lower the threatened status of this species.

Jurong city has become the base of commercial production for many agricultural products including tea, fruits and flowers, and gradually developed into a regional business hub for large-scale, industrialized, specialized and ecological production. However, the use of *Y. zenii* in Jurong City has fluctuated at small scale, low production, and low efficiency, without full utilization of the species potential and popularity in economic development. Although *Y. zeniii* is in high demand, the current seedling production is limited and far below market need. To take full advantage of local resources, meet the needs for modern forestry development and market demand, and promote the industrialization of *Y. zenii* seedling production, it is imperative to increase the protection and cultivation of *Y. zenii*, which align with GBF Targets 5 and 15.



Electron microscopy scanning enlarge by 800 times

Flower petals of *Y. zenii*

Flower of *Y. zenii*

Working towards conservation of *Yulania zenii*.

As our project, the threats to this species were explored through the investigation of its natural populations and the study of population ecology and seed biology characteristics. A conservation strategy will be proposed, including the establishment of *in situ* and *ex situ* protected populations, as well as the effective protection of existing populations. During the three years implementation, some key progress has been made as follows:

1 Conduct wild plant population and habitat surveys in the distributed area

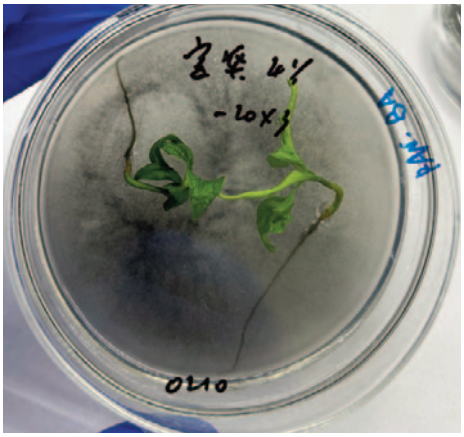
A survey was conducted on the existing wild plants of *Y. zenii*, and a total of 116 plants were found, significantly greater than historic records (18 adult individuals). The growth status of each tree was excellent, with an average height of 21.9 meters and a diameter at breast height of 30.4 cm. Some natural young regeneration trees were found.

Flower of *Y. zenii*

Seeds mixed with sand stored in low temperature

At the same time, flower characteristics were assessed. The color and quantity of the flowers varies greatly, with white on the front, white on the upper back, and purple on the lower part and veins. There are significant differences in flower characteristics, especially in flower color between the plants. Based on this, electron microscopy scanning of pollen was carried out to reveal genetic diversity and correlations between plants from the perspective of palynology.

According to site and habitat investigations, some site conditions do not support successful germination of mature seeds on the ground. When seeds are released from the fruit, they are attached with seed silk and hang in the air. If seeds are not taken by birds or fall to the ground in time, they will slowly lose moisture and become inactive, thereby reducing germination success. *Y. zenii* is a shade intolerant tree species with straight and deep root systems. Therefore, adult plants can obtain nutrients and water from the soil layer under rocks or underground runoff. However, seed germination and seedling establishment require a cool environment at the early stage of growth. As seedlings grow, their tolerance to shade gradually weakens lowering their capacity to grow under high canopy cover, which is not conducive to later growth. In addition, intense interspecific competition (major competitors include *Quercus glauca, Phoebe sheareri, Ulmus pumila*, etc.) may also add to the endangered status of *Y. zenii*.



Seed germination after cold storage

2 Explore propagation methods including cutting, grafting, and sowing

Grafting was the best in the fall compared to other seasons, producing a grafting seedling rate of 73.6% and a total of 48 grafted plants. In 2022 and 2023, fruits of second-generation plantations were harvested, seeds were sown, 350 container seedlings were produced and almost 10 000 seeds are sprouting. This is a breakthrough of progress in cutting propagation. In summer, semi-lignified tender branches were used for cutting experiments. A rooting rate up to 40% was obtained, which will help provide additional plants to those from cutting propagation.

3 Collaborate with the Southwest China Germplasm Bank to conduct seed cold storage and germination experiments.

The seeds of Magnoliaceae plants are mostly recalcitrant and not suitable for long-term preservation. To explore the long-term preservation technology of *Y. zenii* seeds, a study was conducted on *Y. zenii* fruits collected in September, 2022. At that time, fruit peels were green and unopen, indicating that fruits did not fully ripen.

Cutting and high grafting of *Y. zenii*

Immature fruit of *Yulania zenii*

Growth site reinforcements (top) and *in situ* protection population established on *Cunninghamia lanceolata* forest site (above)

The germination rates of fresh seeds and seed embryos were tested along with the dehydration of seeds. The germination rates after three months of cold storage at -20°C and liquid nitrogen (LN) respectively were also tested. At present, experimental work is ongoing. In 2023, fully ripe fruits were harvested, and relevant experiments were continued to compare the consistency and difference of results. These will be used in the conservation strategy to recommend the most appropriate methods to store seeds for long-term conservation.

4 *In situ* conservation and ex *situ* conservation

In situ habitat maintenance and improved conservation measures have been implemented, and the *in situ* conservation population has been established which is achieving GBF Target 2 on Ecological Restoration. This spring, Baohua Mountain Forest Park Management Committee reinforced the larger *Y. zenii* plants that were threatened by site conditions and cleared the invasive plants of *Phyllostachys edulis* that significantly interferd with the growth of *Y. zenii*. These measures help stabilize physiological position, expand growing space required, and significantly improve *Y. zenii* growth. At the same time, in spring, the *in situ* conservation population was established at harvested sites of secondary forests of Chinese fir in the native area of Baohua Mountain. A total of 113 3-year-old *Y. zenii* seedlings were planted, and their current growth is good.

At present, there are 5 grafting plantings and 19 seedlings have been conserved ex *situ* in Shanghai Botanical Garden.

Y. zenii seedling planted in Shanghai Botanical Garden

The seedlings grow well and do not require special maintenance. For cuttings, the number of roots formed is still much less that the rooted plantings face survival challenges after being transplanted. The adventitious roots of the cuttings may be vulnerable and not suitable for immediate transplanting after rooting. At present, the ex *situ* population site construction is being carried out in Jinshan district which is the ex *situ* conservation base of Shanghai Botanical Garden. 200 *Y. zenii* seedlings for the ex *situ* population construction have been prepared for planting.

Seedlings prepared for ex situ population construction

Stakeholder seminars and technical training meetings

5 Actively raise the awareness of integrated conservation for *Y. zenii*

Stakeholder seminars and technical training meetings were held, with a total of 173 trainees over the past three years. Our project team members actively participated in international species conservation conferences and were invited to participate in the GCCM East Asia Regional Meeting organized by the Global Conservation Consortium for Magnolia (GCCM). At the meeting, the progress of the project was shared, and the current conservation and research status of the plant was comprehensively discussed. Online discussion on conservation exchanges was held with Atlanta Botanical Garden, Qianlipu Arboretum in South Korea, and Fairylake Botanical Garden in Shenzhen, China.

Themed biodiversity exhibitions for the protection of endangered species such as *Y. zenii* were actively organized. Shanghai Botanical Garden has launched the "Endangered Wild Plants Exhibition in East China" and the biodiversity exhibition of "Harmonious Coexistence of All Things and Building a Beautiful Home", respectively. "Go to Shanghai Botanical Garden and See the Endangered Plants" was launched in Shanghai People's Broadcasting Station special program "I Wonder Why", which provided the example

Biodiversity Exhibition, 2021

The story of *Y. zenii* was presented in Shanghai People's Broadcasting Station

of "The Story of *Y. zenii*" to explain to the audience the survival status of the endangered tree species and the protection work that has been carried out. This work is unique in tree conservation but aligns with Target 21 of the GBF on raising awareness and public awareness programmes.

The work done by the project partners led by Shanghai Botanic Garden on *Y. zenii* is an excellent example of botanical projects meeting several of the GBF targets focusing on the conservation of a single important tree species.

Thanks for the help provided by Li Jianquan, Yuan Shuai, Wang Qi, Li Zhibo and other staffs from the Zhenjiang Jurong Baohua Mountain National Forest Park Management Committee.

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Shanghai Engineering Research Center of Sustainable Plant Innovation
Shanghai Botanical Garden

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MANAGEMENT OF *EX SITU* COLLECTIONS FOR CONSERVATION: PLANT RECORDS AND SURVIVAL

Plants are reared in the nursery before being planted in public displays (MBG)

Well documented and effectively curated living collections serve as valuable resources for horticulture, conservation, research, and education. The plant records themselves can also be useful to manage *ex situ* collections for species conservation. Here we highlight the use of inventory data to model plant survival. We also illustrate how plant survival models may inform decisions regarding which plant species of conservation concern to grow at a garden and even how many individuals are needed to achieve Target 4 of the Kunming-Montreal Global Biodiversity Framework (GBF).

An embossed aluminum accession tag is created for each plant or group of plants in the living collection. Tags differ in size and color to alert staff to valuable material. (Rebecca Sucher, MBG)

Introduction

Target 4 of the GBF calls for ex *situ* conservation to help combat biodiversity loss and extinction. Botanical gardens are well positioned to meet this call, in large part because they have systems for tracking and maintaining information on living plant collections. Ideally, gardens would use these plant records to help guide ex situ conservation programs.

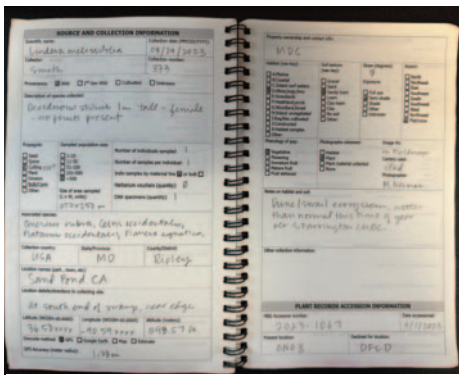
At Missouri Botanical Garden, plant records are compiled and maintained in the Living Collections Management System (LCMS, livingcollections.org), a custom web-based SQL database. The primary users of the LCMS are the horticulture staff charged with building and maintaining the living plant collections, and they can access and update plant records from any web-enabled device. Horticulturists record inventories throughout a plant's life, including when it is moved from the nursery to a display location and upon a plant's death or removal from the garden. Cause of death is recorded as being one of 45 categories, including viral disease, transplant shock, overwatered, slow decline, or function in the garden no longer met. The accessibility of LCMS has contributed to more efficient and accurate record-keeping and overall higher quality plant records.

Wild collected plants are labeled with larger tags that include key provenance information. Rare plants are labeled with black tags. (Georgia Thomas, MBG)

Improving plant records quality, whether it be the inclusion of more provenance information or recording cause of death, is a step all gardens can take as part of standard operations to allow for future innovative data applications to assist with conservation

Modeling Survival

Using plant records maintained in the LCMS, we studied plant survival, a life history trait that determines individual plant turnover in living collections and associated costs (Griffith and Husby, 2010). We modeled the probability of survival through time for perennial plants sourced from wild collected propagules and grown outdoors at MBG between 1990 and 2019. (Thomas et al., 2022). To model survival, we used the dates when individual plants were planted and when they died. Data from plants that were still alive when the data was retrieved, or that were removed from the garden grounds before they died due to changes in garden design or aggressive growth, are useful too. In the survival analysis literature, these latter kind of data are known as "right censored" and contribute to estimates of survival probability. Our study included 1,184 individual plants representing 410 species, selected by horticulture staff based on their aesthetic appeal and an expectation they could survive in MBG's urban location, under a continental climate. They included forbs, herbs, graminoids, shrubs, trees, and lianas.



Sample field book entry with detailed provenance information recorded for wild-collected propagules. (Rebecca Sucher, MBG)

Tracking detailed provenance information is crucial when collecting plant propagules from the wild for the living collection. (Andrew Wyatt, MBG)

The survival models fitted to these data showed that the micro-climate at the propagule collection locality, along with growth form, is useful to predict plant survival in MBG's outdoor landscapes. Although sample size might be small for some species, simultaneous analysis of data from multiple species (using models with random effects) can yield preliminary estimates of survival rates, even for species which the garden has never grown.

Applications of Survival Models

(1) We currently use these models to help guide the selection of new species to be acquired for the living collections at MBG. The predicted survival curve (Figure 2) for a potential accession at MBG is one of several criteria included in a database that horticultural staff use to target new species for MBG's living collection.

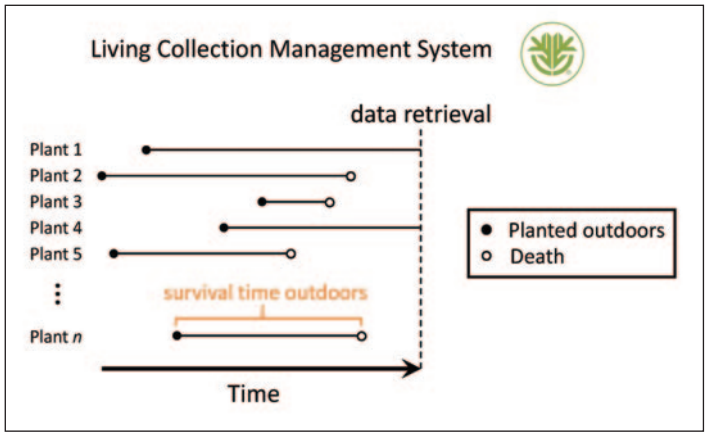
(2) The predicted survival curves (Figure 2) can also help botanical gardens devise ex *situ* conservation plans that account for plant death. We developed optimization models where practitioners set explicit conservation goals for living collections and the reliability with which those goals should be achieved despite plant attrition over time (Thomas et al., 2023). These models are meant to help gardens evaluate explicit ex *situ* conservation goals and the resources needed to meet such goals.

A simple interactive version of the optimization models can be found at mobot.org/conservationhort. In this version, practitioners set four parameters:

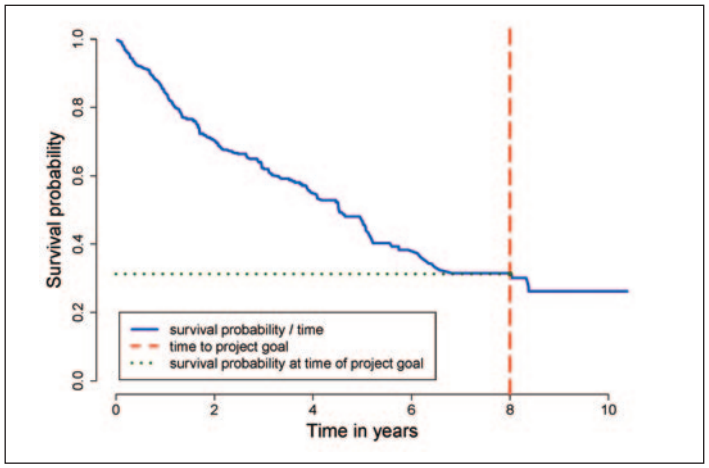
- **Conservation goal** expressed as the minimum number of individual plants that should survive after a given time period (t) in the living collection, where t is the timeframe for the particular ex *situ* conservation program (e.g., supplementing wild population, providing founders for translocation, establishing a breeding population ex *situ*).
- **Range of the number of individual plants that could be included** in the ex *situ* living collection initially (i.e., before plant death). This quantity may be limited by the availability of resources, propagules, space, staff, etc.
- **Reliability with which the conservation goal should be achieved**. This, in turn, defines the assumed risk of failing to achieve the conservation goal.
- **Survival rate**, probability that individual plants survive after the time period t (as defined above). We were able to use our survival models to inform estimates of survival rates but practitioners may use preliminary estimates based on their expertise.

From these parameters, the tool determines the minimum number of initial plants needed to achieve the conservation goal with the set level of reliability.

Optimization models can help gardens evaluate explicit ex situ conservation goals and the resources needed to meet such goals.



Survival was calculated using inventory data from the LCMS. Survival time was calculated using dates of planting outdoors and death. Data for some plants were right-censored, meaning that lifespan beyond the data retrieval date is unknown. Plants that were removed from the garden due to management decisions unrelated to declining plant health were also right-censored. (Georgia Thomas, MBG)



The predicted survival for a potential accession over time where t is the timeframe for the particular ex *situ* conservation program (e.g., supplementing wild population, providing founders for translocation, establishing a breeding population ex *situ*). (Georgia Thomas, MBG)

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Horticulture staff are responsible for tracking and inventorying plants under their care. If a plant dies or is moved, and inventory is expected to be entered into LCMS within a two-week timeframe. If a plant dies, cause of death is a required field for data entry. (Georgia Thomas, MBG)

Conclusions

We highlighted two uses of survival estimates for managing living collections for ex *situ* conservation. In order to make the estimates even more useful, we plan to improve survival models by examining a larger array of plants grown at MBG, including those of cultivated origin. We are collaborating with The Morton Arboretum to understand drivers of survival across multiple institutions and assist gardens in planning their ex *situ* conservation efforts, in particular, developing metacollections of exceptional species in current and future climates.

Survival modeling would not be possible without good record keeping. While maintaining strong plant records is a focus for MBG, our initial survival estimates are limited because out of the 17,801 wild sourced plantings in the LCMS, 65% are missing geographic coordinates for the locality of propagule collection, mostly due to incomplete provenance information in the original data shared with MBG. Additionally, MBG only began consistently recording suspected cause of death in the early 2010s. Improving plant records quality, whether it be the inclusion of more provenance information or recording cause of death, is a step all gardens can take as part of standard operations to allow for future innovative data applications to assist with conservation.

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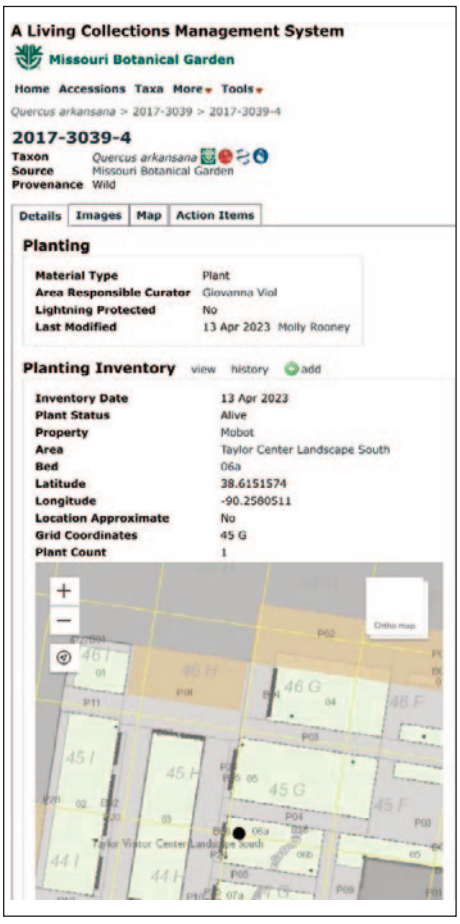

Staff report inventories in LCMS. If a plant dies or is moved, an inventory is expected to be entered in LCMS within a two-week time frame. If a plant dies, cause of death is a required field for data entry. (Rebecca Sucher, MBG)

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CONSERVATION OF RARE AND ENDANGERED PLANTS: A CASE FROM GUIZHOU BOTANICAL GARDEN

Aerial view of Guizhou Botanical Garden

Handeliodendron bodinieri

Guizhou Botanical Garden, in Guizhou Province, China has carried out a series of research on the conservation of rare and endangered plants, including field investigation, ex *situ* conservation, reproduction, scientific research and reintroduction, all of which aid in the conservation of plant species and contribute towards the CBD Global Biodiversity Gardens (GBF).

Introduction

Guizhou Botanical Garden was founded in 1963, affiliated to Guizhou Academy of Sciences, covering an area of 88 hectares and located in the northern suburb of Guiyang, which is 3 kilometers away from old central Guiyang. Guizhou Botanical Garden is the only provincial comprehensive public welfare institution engaged in plant germplasm resources conservation, scientific research, plant exhibition, science communication, development and utilization of plant resources in Guizhou Province.

Guizhou Botanical Garden is recognised as the "National Science Communication Education Base", "National Youth Science and Technology Innovation Education Base", "Guizhou Children & Teenager Science Center", and "Guizhou Youth Science and Technology Innovation Education Base".

Guizhou Botanical Garden has established 10 diverse specified plant collection gardens including Rare Plants Garden, Medicinal Plants Garden, Fruit Trees Garden, Ornamental Display Plants Garden, *Davidia involucrata* Garden, Camellia Garden, *Rhododendron* Garden, Modern Rose garden, Rose garden, Bonsai Garden and the Gesneriad Conservation Center, The garden has collected and conserved more than 3,700 species of living plants, including *Paphiopedilum emersonii*, *Davidia involucrate*, *Handeliodendron bodinieri*, *Emmenopterys henryi* . It has become a 'Fascinating Palace 'of plants biodiversity for citizens to get close to living plants, and a teaching practice base of plant science communication for primary, middle school and university students.

Paphiopedilum emersonii

In the case of orchid (*P. emersonii*) conservation

P. emersonii was a unique species in China that was classified as a level protected plant. It was found only in the narrow karst forests of Guangxi and Guizhou. *P. emersonii* was highly cherished by flower enthusiasts worldwide due to its unique charm and numerous exceptional characteristics, and it holds irreplaceable ecological, economic, scientific, and cultural value. However, rapid urban population growth and intensified economic activities have led to extensive deforestation, resulting in severe damage to ecosystems and the continuous shrinkage and disappearance of suitable habitats for *P. emersonii*'s survival. The species is endangered due to its limited distribution, unique climatic conditions in its native habitat, habitat degradation, and excessive harvesting. Therefore, protecting this speices is of significant importance. Below is the progress of conserving this species made so far.

1. Field surveys

Based on field surveys, it had been observed that this species was exclusively found on the upper slopes at an altitude of approximately 700-800 meters. Its distribution was primarily limited to the cliffs and rocky walls within the Libo Maonan Nature Reserve. It is a perennial herbaceous plant that tends to grow in a semi-epiphytic form on cliffs and rocky walls. It exhibited a weak rhizome ability and often occured in scattered patches. It takes more than three years for the orchid to reach the flowering stage, with blossoms appearing from April to June. The fruits then ripen between September and October. However, it has a low fruit set rate and a limited capacity to regenerate through natural seed dispersal. Within its habitat, it is commonly associated with other plants, such as *Pistacia chinensis, sapium discolor*.

Above left and right: *Paphiopedilum emersonii* field investigation

2. The main factors contributing to the endangered status

(1) Unique biological characteristics

P. emersonii plants are found in delicate limestone mountain areas, specifically in crevices or cracks. They thrive in upper forest environments that offer moist and loose humus soil. These plants heavily rely on their surroundings and mainly reproduce through clonal propagation to increase their population size. In order for its seeds to germinate and develop into seedlings, they require a symbiotic relationship with fungi. If specific fungi or suitable symbiotic environments are lacking, the success rate of seed reproduction is extremely low. Consequently, due to these distinctive biological characteristics, the self-reproduction of this species is limited, leading to their endangered status.

(2) Loss of habitat

This species grows in fragile environments, and surveys have shown that there are very few seedlings. Natural vegetation clearance, grazing, and land development have caused a loss of their living space and fragmented their habitats, resulting in isolated distributions. This disrupts the biological chain of reproduction, leading to a lack of regular pollination and reproduction. This is one of the main causes of the endangered status of this species.

(3) Human activities

Wild populations of *P. emersonii* in Guizhou face ongoing pressures from direct harvesting, which is driven by horticultural work, people's curiosity, and the continuous demand for wild *P. emersonii*. As a result, there has been a direct reduction in *P. emersonii* populations and the destruction of their habitats, leading to a decline in the number of *P. emersonii* populations.

3. Tissue culture

P.emersonii, like most orchids, has non-endospermic seeds that have a very low germination rate and require symbiosis with fungi to germinate in natural environments. The aim of this project was to explore effective methods for the large-scale propagation of *P.emersonii* using its seeds as explants, in order to provide a scientific basis for the conservation and utilization of this orchid species. Through research, it has been determined that the optimal culture medium combination for the sterile germination of *P. emersonii* seeds is MS+6-BA 0.5 mg/L+NAA 0.05 mg/L+100 mL/L coconut milk (Table 1). Additionally, the best proliferation culture combination to promote the differentiation of *P. emersonii* protocorm-like bodies has been found to be 1/2MS+6-BA 1.0 mg/L+NAA 0.1 mg/L+100 mL/L coconut milk (Table 2). The study also revealed that the optimal rooting culture combination for *P. emersonii* is 1/2MS+NAA 0.5 mg/L+IBA 1.0 mg/L+1.0 g/L activated charcoal (Table 3).

Number	Medium	Germination rate /%		
		Culture for 4 weeks	Culture for 6 weeks	Culture for 8 weeks
1	MS	0	0	7
2	MS+100mL / L Banana juice	2	7	13
3	MS+100mL / L Coconut milk	5	10	20
4	MS+6-BA 0.5 mg / L+NAA 0.05 mg / L	0	2	10
5	MS+6-BA 0.5 mg / L+NAA 0.05 mg / L+100mL / LBanana juice	8	17	30
6	MS+6-BA 0.5 mg / L+NAA 0.05 mg / L+100mL / L Coconut milk	12	21	58

Table 1 The influence of medium components on seed germination rate

4. Reintroduction of *P. emersonii*

Due to the continuous loss and fragmentation of *P. emersonii*'s natural habitat, it has now become an endangered species. Reintroduction along with *ex situ* conservation efforts meets Targets 2 and 4 of the GBF The primary goal is to establish populations with sufficient genetic diversity to adapt to evolutionary changes, maintain themselves naturally, and generate new populations. Reintroduction has emerged as a vital strategy for species conservation and population recovery, finding wide application in the conservation practices of various rare and endangered plant species. Consequently, our project team has established three reintroduction sites within the Libo Maonan National Nature Reserve, which is the original distribution area of *P. emersonii*.

The reintroduction of *P. emersonii*

Number	Medium	Differentiation situation	Proliferation situation	
			Multiplication rate	Bud growth situation
1	1 / 2MS+6-BA 1.0 mg / L+NAA 0.1 mg	-	-	-
2	1 / 2MS+6-BA 1.0 mg / L+NAA 0.1 mg / L+100mL / LBanana juice	Turning green	1.3	Slow growth
3	1 / 2MS+6-BA 1.0 mg / L+NAA 0.1 mg / L+100mL / L Coconut milk	Turning green	3.5	Plants grow strong, with lush and dense leaves, and they grow rapidly
4	1 / 2MS+6-BA 1.0 mg / L+NAA 0.1 mg / L+100mL / LBanana juice+AC 0.2 g / L	Turning green	1.8	The growth is vigorous, but the pace is slow.
5	1 / 2MS+6-BA 1.0 mg / L+NAA 0.1 mg / L+100mL / L Coconut milk+AC 0.2 g / L	Turning green	2.0	Moderate growth

Table 2 Differentiation and proliferation culture of protocorms

Number	Medium	Germination rate /%		
		Root culture time	Rooting rate	Root number
1	1 / 2MS+NAA 1.0 mg / L	-	-	-
2	1 / 2MS+IBA 1.0 mg / L	-	-	-
3	1 / 2MS+NAA 0.5 mg / L+IBA 1.0 mg / L	53 d	32%	2-3
4	1 / 2MS+NAA 0.5 mg / L+IBA 1.0 mg / L+ 1.0 g / L AC	35d	65%	4-5

Table 3 The effect of different culture media on the rooting of *P.emersonii*

P. emersonii tissue culture

5. Lessons learned and recommandations

P. emersonii is only found on cliffs or rock walls within the Maolan Nature Reserve's forest. Its native habitat has harsh and complex conditions, with a unique climate. Based on the experimental results of this study, the following conservation suggestions are proposed:

- It is recommended to select climate and soil conditions similar to the original habitat. During the early stage of natural regeneration, clear the aboveground parts of other plants in the sample area, while considering the important role of the white-flowered Coelogyne's complex root system in stabilizing the soil on the rock walls. Additionally, it is necessary to increase the surrounding soil volume appropriately, providing sufficient living space and sunlight for the initial growth of the white-flowered Coelogyne. This will improve the survival rate and enhance its growth potential.

- Regeneration is only the beginning of population reconstruction, and later monitoring and management pose even greater challenges. There are still many issues to be explored, such as population structure, genetic diversity, and the interactions with the original community in the regenerative area.

In conclusion, the reintroduction of *P. emersonii* in the wild is of great importance for the conservation of ecological balance, population preservation, and biodiversity protection. It is a matter concerning environmental conservation and sustainable development, contributing to the preservation of our shared natural heritage.

Test site	Area (m^2)	Area (m^2)	Survival rate (Plant)	plants flourish
1	10	30	7	Good growth
2	8	30	5	Good growth
3	9	30	9	Good growth

Table 4 Basic information of the reintroduction place

The reintroduction of *P. emersonii*

Yan Zhou:
Guizhou Botanical Garden

Yanqian Zhang:
Guizhou Maolan Karst Forest

Authors: Elianne Lee, China Williams and Sonia Dhanda

PARTNERSHIPS FOR PLANT CONSERVATION: HOW THE ROYAL BOTANIC GARDENS, KEW CONTRIBUTES TO THE GBF TARGETS

Nature Connectedness. (Visual Air, RBG Kew)

This article features three case studies, led by researchers at the Royal Botanic Gardens, Kew (Kew), to illustrate the measured impacts of centering long-term partnerships and projects prioritising local knowledge. These examples highlight how capacity building and scientific and technical exchange are at the heart of enhancing our abilities to achieve the Global Biodiversity Framework (GBF).

Introduction

The global plant and fungi conservation community has two decades of experience coordinating international action, focus and accountability. It is driven by the international policy agenda through the Global Strategy for Plant Conservation (GSPC) targets. This global community including scientific institutes and botanic gardens continue to use this framework to implement plant and fungi conservation, and an updated plant focused programme will help achieve the renewed global biodiversity goals and targets under the Convention on Biological Diversity's GBF.

Plant and fungal research are vital for addressing the challenges facing humanity and addressing the global conservation efforts as initiated through the GBF. Kew works with partners in over 100 countries, and we have selected three case studies to demonstrate how long-term partnerships and projects that prioritise local knowledge and capacity exchange have been vital for success in implementation. These include a restoration programme in Mexico, agrobiodiversity in Ethiopia, and a programme implementing nature-based solutions (NbS) in the UK. Each site offers unique opportunities and challenges for the conservation and sustainable use of plant diversity as detailed with a focus on lessons learned, replicability and opportunities to upscale.

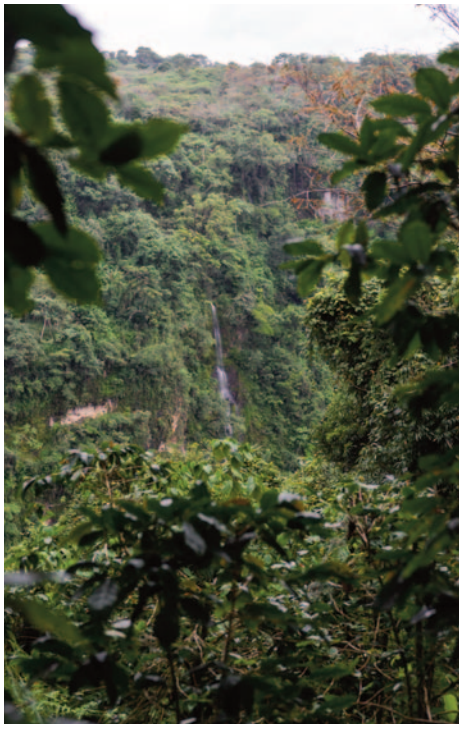
Botanic Gardens have a particular role in working together as a sector and within their local and national communities. Efforts may focus on the set of Complementary Actions for plants, based on previous experiences implementing GSPC, as part of the monitoring framework supporting the 23 actionable GBF targets. They are due to be adopted by Parties at CBD COP16.

Case study 1:

Restoring native trees in Mexico important to local communities and developing income generation strategies

Information provided by Lizzie Bell (Kew)

Background: This programme supports the restoration of natural capital to benefit local communities, focusing on endangered and threatened tree species, among which oaks such as *Quercus isignis* and *Quercus pinnativenulosa*. **Pine-oak forests and tropical cloud forests are critical biodiverse ecosystems of southeast Mexico, occupying less than 1% of the total area of Mexico but representing 12% of all species in the country. Trees play a central role in local livelihoods by providing resources like building materials, food, and medicines**. Native tree seeds of local use were prioritised through a participatory approach. Beginning in 2015, Kew has been working with Facultad de Estudios Superiores Iztacala of the Universidad Autónoma de Mexico (Fes-I UNAM) to catalogue, conserve and reintroduce native trees important for local communities. As part of this programme, a checklist of Mexican native trees has been compiled (Tellez et *al*, 2020). Building on this checklist, native tree species are prioritised based on a science-based approach (distribution, conservation status, seed and plant traits) combined with a participatory approach with local communities (human uses and ecosystem services), tailoring species selection to each project within the programme.



Peering through the trees into the heart of Veracruz's cloud forests. (Alejandro Guerrero Lara)

Small holder coffee producers ranking selected species based on multiple criteria. (Alejandro Guerrero Lara)

Positive impacts: Over 400 native tree species from across Mexico have seeds collected and banked at Fes-I UNAM, as well as duplicated at Kew's Millennium Seed Bank. In 2022, Kew partnered with Herbal Essences, who source aloe vera for their cosmetic products from Mexico, through the 'Replant Our Plant' campaign to fund community-based replanting of 200,000 trees in Veracruz. The NGO Pronatura Veracruz A.C. (PNV) has been working with locals to identify and locate native tree species vital to their communities, applying Gender Equality and Social Inclusion (GESI) principles. Local women are also supported as they comprise 60% of the people employed in local nurseries to propagate trees for replanting.

Challenges: When areas of Veracruz have been reforested using non-native species, resulting ecosystem damage can outweigh benefits, emphasising the critical need to engage and work with local generational knowledge of planting the right trees in the right areas. Another major challenge found by literature review surveys is the lack of knowledge in how to germinate wild species seeds once they have been stored (Rodríguez-Arévalo et *al*., 2017). Furthermore, while the State of Veracruz has been identified as a priority terrestrial site and part of the Mesoamerica Biodiversity Hotspot, it is not under land protection by the Mexican government and continues to face some of the highest deforestation rates in the world. Threats to native trees like habitat destruction and deforestation for timber, as well as land-use changes for agricultural purposes, increasingly alter local and cultural livelihood practices.

Lessons learned: This programme's projects contribute to Target 20 of the GBF, which aims to strengthen capacity building, technology transfer, and scientific and technical cooperation. Technical information sheets were produced to disseminate information of seed traits, germination, plant description, conservation and propagation, to practitioners and the public on 22 species, with 7 more in a UK PACT-funded project on carbon capture in coffee plantations also being produced. Effective restoration is promoted through collaboration, with capacity building through the promotion of joint scientific research and providing income opportunities. Kew scientists working together with BGCI set out the 10 Golden Rules for Reforestation, which includes working with local people on these projects.

Case study 2:

Building incentive mechanisms for agrobiodiversity conservation in Ethiopia (enset)

Information provided by James Borrell and Sophie Jago (Kew)

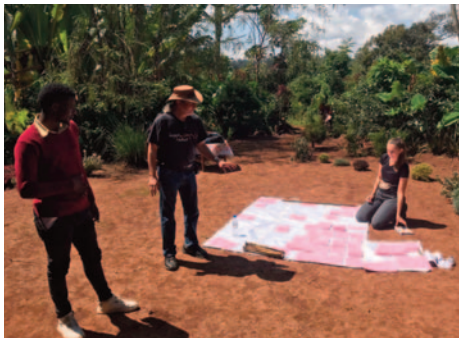
Background: Enset (*Ensete ventricosum*) is a perennial banana relative which has only ever been domesticated in southwestern Ethiopia. Its hundreds of unique landraces, harvest flexibility and high productivity characterise this as a starch staple for ~20 million Ethiopians (Borrell et *al*., 2019). The project worked with local farmers in the buffer zone of Kafa Biosphere Reserve and aims to mitigate the loss of agrobiodiversity by focusing on the crop enset, through a 'payments for agrobiodiversity conservation' scheme (PACS).

Conceptually, it resembles the 'Payments for Ecosystem Services', and aims to reward farmers and incentivise the conservation of food crop diversity.

As a part of the project, researchers work with farmers to understand fair and cost-effective levels of compensation for growing rare landraces and contributing to global good. Compensation takes form as payment-in-kind (paid with product, service, or equity) rather than monetary compensation. Farmers can choose which items they would like to receive within the value of agreed compensation..

Positive impacts: The project so far has identified numerous unique enset landrace among hundreds of farmers and categorised these into rarity groups. While in some cases these landraces may not be presently useful, their conservation is critical for adapting to future climate changes. The project is now in its third phase where farmers are planting these rarer landraces to increase their abundance in the region. Anticipated project outputs include an increase in agrobiodiversity metrics within participating communities in Ethiopia, and an increase in long term climate resilience.

Challenges: Monoculture farming threatens agrobiodiversity, often driven by globalisation and popular culture influencing dietary preferences, cultures, livelihood systems, and shaping the foods traditionally consumed by local communities. Subsistence farmers who are the main actors in managing and conserving agrobiodiversity, as well as associated traditional knowledge, may receive minimal rewards relative to their contribution to maintaining resources for humanity. **Furthermore, considerations of local gender dynamics in enset expansion could be considered, as Ethiopian women play an essential role in its cultivation and are solely responsible for the labour-intensive process as well as landrace selection (Tsegaye and Struik 2002; in Koch et *al*., 2021).**



Project team carrying out focus group discussion to understand rarity of different landraces within community. (Sophie Jago)

Enset monitoring check. (Sophie Jago)

Lessons learned: Underutilised and indigenous crops with useful traits provide a resilient strategy to meeting food and nutritional security goals when cultivation is expanded (Chase et *al*., 2022). Species which are highly flexible and productive strengthen local food security and are central resistors to cropland expansion, in turn, minimising biodiversity loss. Using these species' unique traits to mitigate climate change impacts on biodiversity are illustrative of Target 8, specifically in using enset to focus on building resilience through NbS. When farmers have the financial assurance to invest in recommended inputs such as enset, the likelihood of correct implementation increases, resulting in higher yields and credit repayment capacity (Alliance Biodiversity International and CIAT). Using PACS, this project achieves aspects of Target 18 by scaling-up positive incentives and subsidies in a proportionate and fair way through consulting local farmers. This strengthens incentives for financial institutions to bundle input insurance, agronomic practices and credit, thus mitigating cost risks and safeguarding smallholder farmers.

Case Study 3:

Nature Unlocked: the Landscape Ecology Programme at Wakehurst

Information provided by Lyndsey Fowks (Kew)

Background: Nature Unlocked at Wakehurst is researching UK nature-based solutions for societal and environmental challenges. With a focus on climate change, research includes sustainable and regenerative land management, restoring natural ecosystems, and creating new ecosystems with symbiotic benefits for people and the environment. Aligning with the GBF 30 by 30 targets to protect 30% of UK land and sea by 2030, the Landscape Ecology Programme aims to provide accurate science to inform landscape-scale initiatives, like new faring schemes, that aim to contribute 80-100% of the target to restore and create more than 500,000 hectares of wildlife-rich habitat outside of protected areas by 2042. The programme addresses land use change as a key driver leading to the UK's status as one of the most nature-depleted countries in the world, with almost a fifth of UK plants threatened with extinction.

Nature Connectedness. (Visual Air, RBG Kew)

Positive Impacts: This project collaborates with stakeholders at multiple levels, including the government, conservation groups, corporates, land managers, farmers, the public and scientists. A study in 2022 evaluating the impact of varying landscapes on human wellbeing had over 300 members of the public contribute to research which empirically measured the benefits of nature for people. It was accompanied by a further study involving over 1000 young participants, developed in partnership with 36 schools local to Wakehurst. **Since 2021, Nature Unlocked has measured and modelled the multiple 'stacked' benefits of biodiverse landscapes, focusing on the ecosystem services of carbon, hydrology, pollination and wellbeing**. The Wakehurst landscape is used to test and develop novel methods, protocols, and models, which are then scaled to wider UK landscapes to evaluate trade-offs and reach balanced outcomes for people, biodiversity and the climate.

Challenges: A report by the Royal Society on multifunctional landscapes and role of NbS in UK contexts identified key challenges as competing interests in land use and fragmented land ownership (Seddon et *al*., 2020). Balancing market products, such as food and timber, alongside non-market outputs, such as carbon sequestration, biodiversity, and recreation value, was also an issue for attention. Data-driven research is required to reduce negative trade-offs and increase benefits shared across multiple stakeholder groups.

Lessons learned: Nature Unlocked partnered with Sky to produce Ten Guiding Principles for Investing in Nature (Roberts et al., 2023). These collaborations enable businesses to assess and reduce biodiversity-related risks, to achieve meaningful and ethical impact in nature investment, and through Kew's research to generate valuable evidence, shape progress of Target 15 to encourage and enable public policy and corporate strategies.

Key decision makers are looking for better science, specifically on biodiversity, to inform decision making.

Nature Unlocked carbon research. (Jim Holden, RBG Kew)

Hydrology research. (Jim Holden, RBG Kew)

Nature Unlocked is positioned to provide this, with this open source guiding principles document being just one example of their contribution to research.

Conclusion

Botanic gardens can serve actionable contributions to the GBF through research and collaborations centering local priorities in restoration efforts, incorporating effective incentive mechanisms with consultation of local partners, and finally, encouraging nature-based solutions and providing businesses with biodiversity science to guide decision making. Coming together to produce plant conservation research which benefits both global and local communities involves capacity exchange and participative approaches, in turn strengthening project success and building meaningful partnerships. These priorities aim to deliver the equitable and inclusive participation and access to justice for indigenous peoples and local communities, being the cornerstone of GBF's Target 22. The above three case studies are just the beginning of opportunities to replicate effective plant conservation and restoration at larger scales.

Pollination research (Jim Holden, RBG Kew)

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CONSERVATION HORTICULTURE: STRENGTHENING CAPACITY FOR CONSERVATION ACROSS THE CARIBBEAN

Summary

The Caribbean region has a rich diversity of native plant species but faces significant threats including hurricanes, development, and limited resources. To address the threats to biodiversity, botanic gardens within the region are increasingly shifting the focus of living plant collections to prioritize conservation and education. In the fall of 2023, a workshop on conservation horticulture was held to build capacity and promote the adoption of conservation practices. The workshop's impact was profound and serves as a successful model for future training opportunities in the region and globally. Continued investment in capacity building initiatives is essential to ensure progress towards plant conservation targets and ultimately global conservation goals such as the Global Biodiversity Framework set of goals and targets.

Strengthening Capacity

The Caribbean region boasts an incredible diversity of endemic plants, many of them considered at risk or endangered. Though the total land area of the region is relatively small, it includes a native flora totaling nearly 11,000 species of vascular plants with rates of endemism as high as 70 percent in some countries. The two largest islands contributing to this plant diversity in the Caribbean are Cuba, with over 6,500 native vascular plants, and Hispaniola, including Haiti and the Dominican Republic, with approximately 5,200 and 5,600 native vascular plants respectively. This diversity, however, faces significant and immediate threats from hurricanes, sea-level rise, development, invasive species, and a limited availability of resources to adequately conserve plant diversity in gardens living collections.

Top: Fieldwork experience building conservation collections, Jardín Botánico Nacional, Havana, Cuba. (Chad Washburn)

Conservation Horticulture Workshop Participants at the Jardín Botánico Nacional in Havana Cuba. (Planta)

Today there are over 220 botanic gardens in the countries and territories in the Caribbean region. Many of those gardens are active participants in BGCI's Caribbean and Central American Botanic Gardens Network, established in 2016. The Network serves to build the capacity necessary to conserve the region's flora by supporting the Plant Conservation Strategy for the Caribbean Region. The Strategy, adopted in 2023 by the gardens of the region, contains a series of 20 Targets to be achieved by 2030 in support of the plant conservation actions linked to and in support of the Global Biodiversity Framework (2022-2030) of the Convention on Biological Diversity. It emphasizes the need for capacity building for plant conservation throughout the region and stresses the urgent need to mobilize the necessary resources to build that capacity.

To face the challenge of conserving plant diversity at a time when threats are increasing and necessary resources are decreasing, BGCI, the Leon Levy Native Plant Preserve, Planta! – Plantlife Conservation Society, and

Hands on experience cleaning and preparing seed collections at the Jardín Botánico Nacional in Havana Cuba. (Chad Washburn)

Classroom training in conservation horticulture at the Jardín Botánico Nacional in Havana Cuba. (Chad Washburn)

Naples Botanical Garden, came together to identify training opportunities that could build on the region's existing resources to grow more capacity for plant conservation. In recent years, there has been a meaningful shift in the focus for many Caribbean gardens to build on the value of botanical and ornamental collections by prioritizing conservation and education goals in living plant collections that ultimately serve to conserve at-risk plant diversity.

Conservation horticulture training was identified as the missing component of many gardens in the region that could help to build the capacity for greater plant conservation while relying heavily on existing resources. As a discipline, conservation horticulture differs from ornamental horticulture in that it focuses less on grounds maintenance and display, while placing greater importance on building collections that represent a wide range of wild taxa that are genetically representative of wild populations. Conservation horticulture requires that practitioners have specialized skills to determine requirements for wild species collection, reproduction, and long-term maintenance.

To address this need, the group hosted "Conservation Horticulture: A Proposal for Botanic Gardens and Conservation Nurseries of the Caribbean", a workshop aimed at building capacity towards the related targets of the Plant Conservation Strategy for the Caribbean Region. The weeklong, hands-on workshop hosted at the Jardín Botánico Nacional in Havana, Cuba, in November of 2023, brought together 51 interdisciplinary professionals from Cuba, the Dominican Republic, the Bahamas, and the United States.

The workshop promoted the adoption, integration, and development of conservation horticulture practices with Caribbean botanic gardens. Most of the group participants represented botanic gardens but included five individuals who work in protected areas, universities, or community projects in collaboration with their local botanic gardens.

The workshop focused on three primary objectives: (1) raising awareness about the need to approach horticulture with a conservation mindset as a means to increase the long-term resilience of botanic garden collections, their value, and their potential to support the recovery of wild populations and habitat restoration; (2) promoting the development of horticulture skills and knowledge by sharing experiences, practicing horticultural techniques and creating channels for networking; and (3) promoting conservation education in botanic gardens to advance the use of generic and conservation collections for public education and engagement in conservation actions.

The program curriculum combined aspects of general conservation topics, a focus on specific methods and techniques for conservation horticulture and conservation education, and applied practices in an outdoor setting. Program facilitators took advantage of the strength of participants specialized knowledge in horticulture, conservation, and education, by encouraging sharing of expertise and information through engaging participants to lead hands-on components of the workshop. Participants with a wide range of specialized knowledge were called upon to share best practices for conservation of particularly challenging taxa or techniques. The workshop also focused on the role of conservation education in expanding the impact of botanic gardens' conservation work in achieving the regional plant conservation goals.

Seed collections for conservation horticulture at the Jardín Botánico Nacional in Havana Cuba. (Chad Washburn)


Collecting seeds for conservation collections at the Jardín Botánico Nacional in Havana Cuba. (Chad Washburn)

Based on formal survey feedback, the workshop had a profound and multifaceted impact, empowering the participants with practical skills, theoretical knowledge, and a network of support to advance their work in horticulture, plant conservation, and environmental education. Recurring outcomes in participant surveys included the development of practical skills and acquisition of new techniques, the provision of new perspectives on horticulture, conservation, and environmental education, a fresh and inspired approach to conservation work, a fostered sense of community, and an enhanced sense of purpose.

At a time when global plant biodiversity is under significant threat, and many botanic gardens are placing greater emphasis on refocusing plant collections for conservation purposes, the importance of conservation horticulture has never been more apparent. This workshop served as a vital step towards building capacity for plant conservation in the Caribbean region and can serve as a successful model for other training opportunities in the region and around the globe. Continued investment in capacity building initiatives, like this workshop, is essential to ensuring gardens' advancement towards the targets of national and regional strategies for plant conservation and in support of the plant conservation actions of the Global Biodiversity Framework.

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Field experience collecting seed for conservation colletions, Jardín Botánico Nacional in Havana Cuba. (Chad Washburn)

8th Global Botanic Gardens Congress

Botanic Gardens – People and Plants for a Sustainable Future

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Congress	6 August to 9 August 2024
Post-Conference Optional Tour	10 August 2024

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We aim to explore innovative approaches for botanic gardens to fulfill their missions in research, conservation, education, and outreach.

Held in parallel with the Congress is the Singapore Garden Festival (SGF) 2024. Congress participants will enjoy unlimited complimentary entry to the Festival.

FOR MORE INFORMATION

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11TH INTERNATIONAL CONGRESS ON EDUCATION IN BOTANIC GARDENS (ICEBG)

Education for change: botanic garden's role in addressing global challenges

국립수목원

BOTANIC GARDENS CONSERVATION INTERNATIONAL

BGCI is thrilled to announce the 11th International Congress on Education in Botanic Gardens!

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When	9-13th of June 2025 (with a Welcome Day TBC the 6th or the 8th of June).
Where	Seoul, South Korea. COEX Exhibition Hall.
Host	Korea National Arboretum (KNA).
Theme	'Transforming Botanic Garden Education in addressing biodiversity loss and climate challenges'.

Since its inauguration in 1991 to the 10th Congress in 2018, each International Education Congress has brought together educators, practitioners, curators, researchers, and academics, to explore cutting-edge developments in botanic garden education. Held every 3-4 years, these congresses have served as global forums, bringing representatives together to exchange ideas, discuss future priorities, and foster collaborative efforts.

Previous congresses have tackled themes spanning sustainability, global awareness, biodiversity conservation, and community outreach. The journey began in the Netherlands in 1991, cantered around "A natural environment for learning," and continued with themes like "Green Awareness" in Gran Canaria, "Action Learning" in Durban, and celebrating the 200th anniversary of the University of Warsaw Botanic Garden in 2018.

As we gear up for the next edition, the 11th Congress carries this legacy forward, placing a strong emphasis on the role of botanic garden education to address pressing global challenges.

Looking ahead, the 11th ICEBG, hosted by the Korea National Arboretum, promises to be an engaging experience. The congress will offer a unique opportunity to collaborate with international education experts, gain insights from diverse perspectives, and contribute to a collective effort in addressing environmental challenges. To ensure global accessibility, this Congress will be a hybrid event, allowing participation either in person or online.

We look forward to welcoming as many of you as possible at the 11th ICEBG in South Korea! Stay tuned for more details!