Recent initiatives to develop biocontrol for the Pacific: strategy workshop and weed prioritisation exercise

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BIODIVERSITY CONSERVATION LESSONS LEARNED TECHNICAL SERIES

5

CONSERVATION INTERNATIONAL
Pacific Islands

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Manaaki Whenua
Landcare Research

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CONSERVATION INTERNATIONAL
Pacific Islands

CRITICAL ECOSYSTEM PARTNERSHIP FUND

The **Critical Ecosystem Partnership Fund** is a joint initiative of l'Agence Française de Développement, Conservation International, the European Union, the Global Environment Facility, the Government of Japan, the MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation.

ABOUT THE BIODIVERSITY CONSERVATION LESSONS LEARNED TECHNICAL SERIES

This document is part of a technical report series on conservation projects funded by the Critical Ecosystem Partnership Fund (CEPF) and the Conservation International Pacific Islands Program (CI-Pacific). The main purpose of this series is to disseminate project findings and successes to a broader audience of conservation professionals in the Pacific, along with interested members of the public and students. The reports are being prepared on an ad-hoc basis as projects are completed and written up.

In most cases the reports are composed of two parts, the first part is a detailed technical report on the project which gives details on the methodology used, the results and any recommendations. The second part is a brief project completion report written for the donor and focused on conservation impacts and lessons learned.

The CEPF fund in the Polynesia-Micronesia region was launched in September 2008 and will be active until 2013. It is being managed as a partnership between CI Pacific and CEPF. The purpose of the fund is to engage and build the capacity of non-governmental organizations to achieve terrestrial biodiversity conservation. The total grant envelope is approximately US$6 million, and focuses on three main elements: the prevention, control and eradication of invasive species in key biodiversity areas (KBAs); strengthening the conservation status and management of a prioritized set of 60 KBAs and building the awareness and participation of local leaders and community members in the implementation of threatened species recovery plans.

Since the launch of the fund, a number of calls for proposals have been completed for 14 eligible Pacific Island Countries and Territories (Samoa, Tonga, Kiribati, Fiji, Niue, Cook Islands, Palau, FSM, Marshall Islands, Tokelau Islands, French Polynesia, Wallis and Futuna, Eastern Island, Pitcairn and Tokelau). By late 2012 more than 90 projects in 13 countries and territories were being funded.

The Polynesia-Micronesia Biodiversity Hotspot is one of the most threatened of Earth's 34 biodiversity hotspots, with only 21 percent of the region's original vegetation remaining in pristine condition. The Hotspot faces a large number of severe threats including invasive species, alteration or destruction of native habitat and over exploitation of natural resources. The limited land area exacerbates these threats and to date there have been more recorded bird extinctions in this Hotspot than any other. In the future climate change is likely to become a major threat especially for low lying islands and atolls which could disappear completely.

For more information on the funding criteria and how to apply for a CEPF grant please visit:

- www.cepf.net/where_we_work/regions/asia_pacific/polynesia_micronesia/Pages/default.aspx
- www.cepf.net

For more information on Conservation International's work in the Pacific please visit:

- www.conservation.org/explore/asia-pacific/pacific_islands/pages/overview.aspx

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CRITICAL ECOSYSTEM PARTNERSHIP FUND

CONSERVATION INTERNATIONAL Pacific Islands

Location of the project in the Polynesia-Micronesia Biodiversity Hotspot

Contents

Lessons Learned

Project Design Process

Aspects of the project design that contributed to its success/shortcomings.

Workshop

Having a multi-agency organising committee created challenges (e.g. organizing teleconferences to discuss workshop arrangements with people in different time zones) but allowed access to a wider range of skills and networks. Having a wide Pacific representation at the workshop allowed for excellent information-sharing, networking and problem solving.

Prioritisation Exercise

It would have been easier to get more input from Pacific botanists if the time frames for this project had not been so tight.

Project Implementation

Aspects of the project execution that contributed to its success/shortcomings.

Workshop

It was essential to have a good workshop organiser, to assist with the workshop logistics, and to have strong and effective facilitation in order to achieve the workshop's aims. This was money well spent.

Prioritisation Exercise

Information provided by the Pacific Island Ecosystems at Risk (PIER) website (http://www.hear.org/pier/) was particularly useful. However, information regarding the current legal status (for example, whether cultivation is banned) of weeds in the Pacific region was difficult to find.

Other lessons learned

relevant to the conservation community

Workshop

It was disappointing that some participants left securing travel visas until the last minute which meant one person was unable to travel, and several others nearly missed out. I would recommend that organizing committees who are paying for participants' travel do not purchase air tickets until participants provide proof that they have a valid visa. It was also disappointing that some people decided not to come after tickets had been purchased, for various reasons. I would recommend that organizing committees, who are paying for participants' travel, make it a condition that participants' employers sign an agreement that they will reimburse the organizing committee for any travel booked that is not refundable if their employees are no-longer able to travel owing to a change in work commitments.

PART 1

Workshop to Develop a Biocontrol Strategy for the Pacific 2009

16-18 NOVEMBER 2009, AUCKLAND, NZ

Sarah Dodd and Lynley Hayes

Landcare Research

New Zealand

Landcare Research Contract Report: LC0910/069

PREPARED FOR FUNDERS: Critical Ecosystem Partnership Fund, Hawaii Invasive Species Council, Landcare Research, NZAID, USDA Forest Service, United States State Department

DATE: December 2009

Approved for Release by:

Matt McGlone

Science Team Leader

Biodiversity and Conservation

Manaaki Whenua
Landcare Research

Summary

The Workshop

The Pacific Biocontrol Strategy Workshop was held at the Waipuna Hotel and Conference Centre, Panmure, Auckland, New Zealand, on 16–18 November 2009. There were 47 participants, representing 17 countries and territories (American Samoa, Australia, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, Guam, Hawai'i, New Caledonia, New Zealand, Palau, Papua New Guinea, Samoa, Tonga and Vanuatu, United States of America, and the United Kingdom). Also there were organisations representing the Pacific Region (Pacific Invasives Learning Network (PILN), Secretariat of the Pacific Community (SPC), the Pacific Invasives Initiative (PII), and the University of the South Pacific (USP).

Workshop purpose

The workshop brought key players together to see whether biocontrol of widespread invasive species could be undertaken on a more co-operative and collaborative basis in the Pacific, and to develop a regional strategic plan that would allow this to happen. The workshop:

- Reviewed biocontrol activities and programs in the Pacific
- Identified capacity gaps and barriers to using biocontrol to manage invasive species
- Identified opportunities and actions to increase biocontrol work in the Pacific
- Discussed criteria for selecting priority species for biocontrol
- Identified priority species for biological control in the Pacific
- Identified actions and mechanisms for increasing the understanding and acceptance of the use of biocontrol as a management tool in the Pacific
- Identified potential funding sources for biocontrol projects
- Created a steering group to assist in the implementation of the regional strategic plan developed

Key outcomes

At the time of the workshop, a number of outcomes were identified and recommendations made:

- Biocontrol projects undertaken to date in the Pacific have demonstrated that biocontrol is a highly successful and relatively inexpensive tool for controlling pests and diseases in the Pacific.

- The amount of biocontrol activity should be increased in the Pacific, as this is the only feasible way of dealing with many pests.
- A list of species that should be targeted for biocontrol has been prepared, but should be considered a working list that is reviewed regularly.
- Many well-known, highly effective biocontrol agents are available in the Pacific that could be shared much more widely at low cost right now.
- Biocontrol needs to be developed for many more species and some key projects have been identified for development that will be submitted to funders within the next 12 months.
- An independent advisory group will be set up that could review biocontrol agent release applications and provide independent advice to governments.
- Initiatives will be undertaken to increase communication both within the biocontrol community and externally with all stakeholders.

1 Introduction

The Pacific Biocontrol Strategy Workshop was held at the Waipuna Hotel and Conference Centre, Panmure, Auckland, New Zealand, on 16–18 November 2009. There were 47 participants (Figure 1), representing 17 countries and territories (American Samoa, Australia, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, Guam, Hawai'i, New Caledonia, New Zealand, Palau, Papua New Guinea, Samoa, Tonga and Vanuatu, United States of America, and the United Kingdom). Also there were organisations representing the Pacific Region (Pacific Invasives Learning Network (PILN), Secretariat of the Pacific Community (SPC), the Pacific Invasives Initiative (PII), and the University of the South Pacific (USP). Local New Zealand tangata whenua representatives from the Tamaki Regional Mana Whenua Forum and Ngāti Poa also took part. The workshop was facilitated by Michele Frank and Harley Spence of From Agenda to Action. (See Appendix 1 for full list of workshop participants and their affiliations.)

FIGURE 1 Participants at the Pacific Biocontrol Strategy Workshop 2009.

Workshop purpose

To bring key players together to see whether biocontrol could be undertaken on a more co-operative and collaborative basis in the Pacific.

Workshop goal

To develop a regional strategic plan for undertaking biological control of widespread invasive species in the Pacific Islands on a more co-operative and collaborative basis.

Workshop tasks:

- Review and update biological control activities and programmes in the Pacific.
- Identify existing capacity* gaps and barriers to using biocontrol to manage invasive species.
- Identify opportunities and actions to increase biocontrol work in the Pacific.
- Discuss the criteria for selecting priority species for biological control.
- Identify priority species for biological control in the Pacific.
- Identify actions and mechanisms for increasing the understanding and acceptance of the use of biocontrol as a management tool in the Pacific.
- Identify potential funding sources for regional programmes.
- Create a steering group or working group to assist in the implementation of the regional strategic plan.

**Capacity gaps include staffing, infrastructure, legislation, regulation, access to expertise, research, institutional and public support.*

Funding to allow this workshop to proceed was provided by the Critical Ecosystem Partnership Fund, Hawai'i Invasive Species Council, Landcare Research, NZAID, USDA Forest Service, and United States State Department. This workshop would also not have been possible without support from the Pacific Invasives Initiative, Pacific Invasives Learning Network, The Secretariat for the Pacific Community, and The Secretariat for the Pacific Regional Environment Programme. Funding provided by the Australian Centre for International Agricultural Research allowed two additional participants to attend.

The organising committee for this workshop comprised Lynley Hayes (Landcare Research), Anne Marie LaRosa and Tracy Johnson (USDA US Forest Service), Warea Orapa (Secretariat for the Pacific Community), Mark Bonin (Pacific Invasives Learning Network), Alan Tye (Secretariat for the Pacific Regional Environment Programme), and Souad Boudjelas (Pacific Invasives Initiative).

Workshop agenda

Time	Session	Who
Day Two: Sunday 15 November		
1.30–4.30	Pre-workshop field trip for early arrivals to see local weeds and biocontrol agents.	
6.00	Māori welcome	
6.30	Welcome function.	
7.15	Dinner	
8.00	Introductions	
Day Two: Monday 16 November		
8.30	Workshop purpose and outcomes Agenda, Housekeeping	Anne Marie LaRosa
9.00	Keynote Address: Biological control in IPM programs in the Pacific	R. Muniappan
9.30	History of weed biological control in the Pacific	Warea Orapa
10.00	Morning tea	
10.30	History of arthropod biocontrol in the Pacific	Sada Lal
11.00	Cook Islands biocontrol activities – selected case studies	Maja Poeschko
11.20	Biological control of Coccinia grandis on Mariana Island	G.V.P. Reddy
11.40	Biological control of fruit flies by two parasitoids, Fopius arisanus and Diachasmimorpha longicaudata, in French Polynesia	Rudolph Putoa
12.00	Biological control program in Samoa	Billy Enosa
12.15	Lunch	
1.00	Invasive plant species in Pohnpei with references to biological control of Chromolaena odorata	Konrad Englberger
1.20	Biocontrol of Chromolaena odorata and Mikania micrantha in PNG	Annastasia Kawi & Michael Day
1.40	Biological control of weeds in Vanuatu	Sylverio Bule
2.00	Biological control of Erythrina gall wasp	Juliana Yalemar
2.15	Biocontrol in New Caledonia: from the past to the future	Bruno Gatimel, Christian Mille & Herve Jourdan
2.30	Weed biological control in Queensland	Michael Day
2.45	Forest weeds targeted for biocontrol in Hawai'i	Tracy Johnson
	Establishment of the lady beetle, Rhyzobius lophanthae, for biological control of the Asian cycad scale, Aulacaspis yasumatsui in Palau	Fred Sengebau
3.00	Afternoon tea	

3.30	Lessons learned: What has worked and what hasn't?	Break out groups and group discussions
4.00	Update on capacity survey	Anne Marie LaRosa
4.15	Gathering information for Weed Target List	Mic Julien & Warea Orapa
4.55	Feedback on Day One	
5.00	Day One finishes	
Day Two: Tuesday 17 November		
8.25	Welcome – Outline agenda	Michele Frank
8.30	Potential for biological control of weeds in the Pacific	Mic Julien
9.00	Worldwide biological control of arthropods from a Pacific perspective	Ross Miller
9.30	Overview of regulations and legislation governing biocontrol in the Pacific	Roy Masamdu
10.00	Morning tea	
10.30	Identifying barriers and capacity gaps	Break out groups
11.30	Solutions to barriers and capacity gaps	Break out groups
12.30	Lunch	
1.30	Report back	
2.00	Science-based system for selecting/prioritising targets for biocontrol of weeds and insect pests. Work through some Pacific examples and discuss usefulness to Pacific	Quentin Paynter
3.30	Afternoon tea	
4.00	Identify priority species for biological control in the Pacific.	Weed and arthropod breakout groups
4.45	Group reunited and Steering Group members decided	
4.55	Feedback on Day Two	
5.00	Day Two finishes	

Day Three: Wednesday 18 November		
8.30	Introduction to Day Three	
8.35	Recap on Priority Target Species	
10.00	Morning tea	
10.30	Identify barriers to biocontrol – how does external/public perceptions by stakeholders, decision makers influence success of biocontrol programmes – what are the outreach/education needs? What is currently available? Identify actions to overcome barriers	Break out groups
11.15	Review current communication gaps and determine how to increase regional co-operation and communication (internal and external). Key messages on biocontrol. Identify actions to improve communication	Regional break out groups
12.00	Lunch (First Steering Group Committee meeting)	
1.00	Identify and list funding opportunities	Group discussion
1.40	Strategic Plan: Identify projects for research proposals, by whom, by when and funders to be targeted	Group as a whole
3.00	Afternoon tea	
3.30	Summing up and farewells. Evaluation form	
4.00	Workshop ends	
Day Four: Thursday 19 November		
Trip organised to visit Landcare Research and MAF Biosecurity New Zealand facilities at Tamaki, for those participants with later flights.		

2 Field Trip

On the Sunday afternoon prior to the workshop beginning, 19 participants took up the offer from Landcare Research staff to visit some of their weed biocontrol sites in East Auckland. Three sites were visited (Mt Wellington Reserve, Bastion Point cliffs and Orakei) to illustrate their biocontrol programme for the weeds present. Highlights included seeing the bridal creeper rust (*Puccinia myrsiphylli*) and the mist flower white smut (*Entyloma ageratinae*), which have successfully controlled bridal creeper (*Asparagus asparagoides*) and mist flower (*Ageratina riparia*) respectively. See Figs 2–4.

FIGURE 2 Sheltering from rain at Mt Wellington Reserve. Weeds at this site included bridal creeper (with rust fungus) and tradescantia, German ivy (with rust fungus), moth plant, and Chinese privet.

FIGURE 3 Bastion Point cliffs where gorse (and associated biocontrol agents), boneseed and pampas are present.

FIGURE 4 Chris Winks showing the successful biocontrol agents on mistflower at Orakei. Other weeds at this site included Japanese honeysuckle, tree privet, giant reed and woolly nightshade.

3 Opening Ceremony

The workshop opened with an official Māori welcome from Ngāti Paoa at 6 p.m. on Sunday night at the lodge. Warea Orapa was delegated the task of representing the workshop participants during the ceremony and made a mighty effort in singing a traditional Papua New Guinean song accompanied by other PNG delegates. Following the official words and songs of welcome, each participant was welcomed by the tangata whenua with a hongi (pressing of noses). Then in accordance with Māori protocol the group shared refreshments and the delegates started to get to know each other. Following dinner at 7 p.m., time was set aside for all the participants to formally introduce themselves to the group. Photos from the opening are presented below (Figure 5).

FIGURE 5 Scenes from the Māori welcome.

4 Day One
Monday 16 November

4.1 Welcome

The workshop started at 8.30 a.m. with a welcome from the facilitator, Michele Frank, followed by an outline of the workshop purpose, goal and tasks, the agenda for the three days, and some general housekeeping.

Purpose:

To bring key players together to see whether biocontrol could be undertaken on a more co-operative and collaborative basis in the Pacific.

Goal:

To develop a regional strategic plan for undertaking biological control of widespread invasive species in the Pacific Islands on a more co-operative and collaborative basis.

Tasks:

- Update current and past projects
- Produce solutions to barriers and capacity issues
- Identify priority solutions
- Identify actions
- Identify potential funding
- Create a steering group

Participants were then asked to write down what they wanted to get out of the meeting. They were told to keep the piece of paper and to check it again at the end of the workshop to assess if their objectives had been achieved.

4.2 Presentations – Update of biocontrol in the Pacific

From 9 a.m. to 3 p.m., 15 oral presentations were given from various participants, discussing examples of biocontrol of invasive species in the Pacific region. The oral presentations started with Ragaswamy (Muni) Muniappan from Virginia Tech, USA, giving the keynote address on 'Biological control in IPM Programs in the Pacific'. Muni gave a very informative talk where he covered the three aspects of biocontrol – relating to invasive alien plants (IAP), invasive alien arthropods (IAA) and invasive alien microbes (IAM) as plant pathogens – giving many examples of successful biocontrol in the Pacific region for each of these targets. Warea Orapa, a Plant Health Advisor for the Land Resources Division of the Secretariat of the Pacific Community, followed (Figure 6) and talked us through the history of biocontrol in the Pacific Islands, focusing on invasive weed target examples.

The next 13 talks covered numerous examples of successful biocontrol in relation to individual countries (see Workshop Agenda for presenters and titles). What became apparent from all the presentations was that there were a lot of synergies between countries in shared weeds and pests, with the potential to share many well-known, highly effective biocontrol agents. The general consensus from the talks was that biocontrol had proven itself to be a useful and relatively inexpensive tool for controlling pests and diseases in the Pacific and therefore warranted further investigation and expansion in the region. The comment was made that although it is really good and encouraging to hear all of the success stories, it would also be useful to hear some of the unsuccessful attempts, so others could learn from the experience. Although examples of weed and arthropod targets important to agriculture were well represented in the talks, there were gaps in the representation of plant pathogen biocontrol and targets important to native ecosystems.

FIGURE 6 Warea Orapa giving his overview.

4.3 Lessons learned: What has worked and what hasn't

Following afternoon tea, participants were allocated to smaller groups and asked to write down what advice they would give an inexperienced group wanting to start a biocontrol programme. The combined list from all the groups is presented below.

- Pick appropriate targets using appropriate tools, e.g. science, economics, likelihood of success etc.
- Get biosecurity right – stop new invasions
- Assess extent of invasion size – is it small or big?
- Get agreement from everyone – is it a target pest?
- Get species identified by specialists
- Look for some quick wins
- Use appropriate tools for appropriate species
- Have deep pockets, make sure you have resources needed, e.g. human, financial, infrastructural
- Develop linkages between agriculture and biodiversity departments early on to avoid conflicts
- Study biology of pest – know limitations of its ecology
- Promote public and legislative awareness of biological control projects
- Do a literature search on natural enemies of target
- Make contact with other specialists and learn from their experiences
- Have regional approach – share costs and effort
- Undertake cost–benefit analysis using economic tools to build support and justification
- Don't do vertebrate biocontrol
- Make government agencies responsible and follow proper channels
- Perform non-target/host specificity screening. Don't rush in and don't give up
- Commit to long-term post-release monitoring
- Consider eradication
- Prepare environmental impact assessments and obtain appropriate permits

4.4 Update of capacity survey

Prior to the workshop Anne Marie LaRosa (Figure 7) sent out a survey form to all participants to get feedback on current biocontrol capacity in each of their countries. Some had not completed the survey form, so more were handed out and people were asked to fill them in and hand them back to Anne Marie by the next morning.

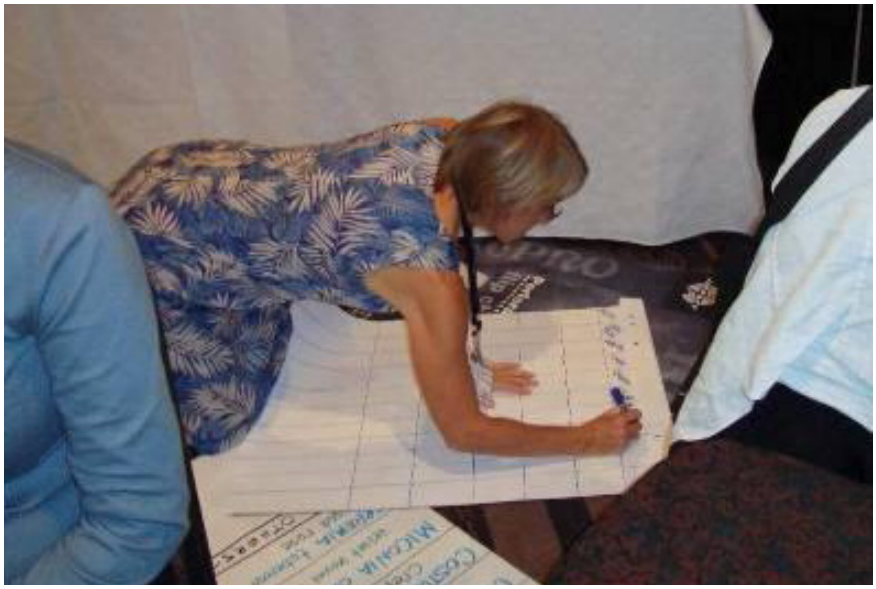

FIGURE 7 Anne Marie getting down to business.

For the survey each Pacific Island country was asked:

- To list the current top 5–10 targets for biocontrol – all taxa (including weeds, insects, pests and pathogens)
- Do you consider biological control a useful tool when faced with pest control in your country? (Y/N, if no why not?)
- Is biological control an integral part of your integrated pest control programs in your country? (Y/N)
- Are training programs offered in local colleges/universities on the use of biological control? (Y/N)

Pacific Island countries and the organisations from developed countries also were asked to provide details on:

- Infrastructure: biocontrol facilities supporting Pacific Island needs (i.e. facility type, if certified, location, size/capacity/age/condition, agents in facility)
- Biocontrol programs supporting Pacific Island needs: Snapshot of last 5 years (country/agency/organisation, average annual budget, number of agents released, number of agents in process, number of countries supported, funding sources)
- Biocontrol staffing: practitioners with projects in the Pacific (i.e. country/organisation, practitioner's name, title, affiliation, email contact, current target weeds, current target pests, current agents in quarantine)

4.5 Gathering information for weed target list

One task for the workshop was to produce a list of prioritised targets for the Pacific. Discussions revealed there were two published lists for weeds but no arthropod list.

On the first day weed targets were dealt with, and a combined list of Pacific Island target weeds generated from published lists of Dovey et al. (2004) and Julien et al. (2006) (see Appendix 3 for full references). This list was placed on the walls and participants were asked to rank each in importance to their own country using the following system: red cross = current biocontrol programme, blue cross= weed present but not a target, and black cross= future target (Fig.8).

In preparation for the workshop Mic Julien had updated his list of 2006 and included agents available for each target. Once the wall sheets were completed Mic and Warea Orapa incorporated this information into Mic's updated list. The updated list is presented in Appendix 4.

FIGURE 8 The target weed list.

4.6 Feedback from Day One

Michele asked participants to share what had worked well today and what we might want to change:

THINGS THAT WORKED WELL: good food, lots of positive biocontrol stories, well organised, high level of engagement.

THINGS TO CHANGE: need pre-warning of things to happen so can give better information, need a PA system, need more time for questions, request for Pacific Islanders to speak up more, low-level engagers and non-speakers encouraged to speak up, hard to see screen, write larger on boards, request to change room arrangement so all face each other, need more donor organisations and legislators present, make media splash.

FIGURE 9 Harley, Michele and Lynley teach the group a waiata.

5 Day Two
Tuesday 17 November

5.1 Welcome – outline agenda

Michele welcomed everyone back to the workshop and outlined the agenda for the day which had changed from the original one sent out. Participants were also reminded to update participant's list details and hand in completed capacity survey forms to Anne Marie.

5.2 Presentations

From 8.30 to 9.30 a.m. three presentations were given. Mic Julien started with a talk on the potential for biocontrol of weeds in the Pacific, where he outlined weed biocontrol examples with relevance to Pacific nations. The aim of his talk was to alert Pacific Island countries to weeds that may have potential for biocontrol and provide a starting point to seek more information. In particular, he highlighted where biocontrol agents are already available for a weed and can be shared with other countries. This was followed by a presentation by Ross Miller, who did an overview of arthropod biocontrol in the Pacific, with particular emphasis on ant invasions. His take-home message was that biocontrol is often the only logical response to invasive insect or weed pests on small Pacific Islands. Pacific Islands rely on biocontrol organisms from previous or ongoing mainland programmes for similar crops, insect pests or weeds. Consequently, international and inter-island cooperation is vital to biocontrol in the Pacific. The third talk was given by Roy Masamdu (Figure 10), who overviewed legislation, regulations and guidelines governing biological control in the Pacific. He explained the regulatory framework in the Pacific region and went through the existing international and regional guidelines currently in use. In particular the International Standard on Phytosanitary Measures (ISPM 3) No 3 – Code of conduct for the import and release of exotic biological control agents (FAO, Rome, 1996).

FIGURE 10
Roy Masamdu talking about guidelines and legislation.

5.3 Identify capacity gaps

After morning tea the workshop participants were split into the four breakout groups: Polynesia, Micronesia, Melanesia, and the co-operating countries and organisations.

Pacific Island groups were asked to list what capacities their countries required to undertake realistic biocontrol in three separate time frames, up to 24 months, 2–5 years and more than 5 years. Co-operating countries and organisations were asked what capacity their country/organisation could offer the Pacific in the same three separate time frames. The results for each group are as follows:

Polynesia

<24 months:

- Funds
- Capacity building: Cook Islands, Tonga, Niue, and Samoa all require biosecurity, plant protection and quarantine staff. All countries (incl. American Samoa and Tahiti) need plant protection training workshops
- Laboratories
- Cook Is – modified air-conditioned zoft container
- Samoa – upgraded lab and post-quarantine screen-house
- Tonga – upgrade existing labs
- Niue – new lab zoft container
- Tahiti – upgrade existing labs and post-quarantine screen-house
- Follow up legislation on pest risk analysis
- Good communication and consultation between ministries/departments
- Public awareness, e.g. radio, TV, pamphlets etc.
- Keen, honest, hard working, and persistent ('never give up easily') workers

2–5 yrs

(sheet not completed)

+ 5 yrs

- Fund for laboratory maintenance and operational costs. (e.g. labs, staff + biocontrol agents)
- Top-up salaries for public servants not consultants
- Evaluation

Micronesia

<24 months:

Guam:

- New regional quarantine facility consisting of 4 quarantine rooms, 2 preparation rooms and 1 office
- Human resources – 1 officer-in-charge

CNMI – 2 quarantine + prep area

FSM – 2 quarantine + preparation area (renovated)

Palau – 2 quarantine + prep area

Marshall Islands – 2 quarantine + prep area + equipment

Human resources needed:

- FSM: Entomologist
- Palau: Entomologist
- Marshall is: Entomologist

Training:

- All sites require ongoing technical staff training

2–5 yrs:

- Facility maintenance at all sites
- Pathogen quarantine facility – Guam only
- Training: ongoing at all sites
- Degree programme scholarships

5+ yrs:

- Upgrade of facilities: CNMI, RMI, RP and FSM
- Training: ongoing at all sites
- Degree programme scholarships

Melanesia (Figure 11)

<24 months:

PNG:

- Funding
- Sub regional network of sharing of ideas and protocols for biocontrol agents
- Specific short-term trainings on handling of natural enemies (rearing/identification), i.e. hands-on training
- Upgrading of the facilities to meet requirements of new biocontrol agents
- Creating awareness
- Conducting PRAs for new BCA introductions

New Caledonia:

- Short-term training on specific BCAs
- Develop and participate on sub-regional network for exchanging BCAs (exchange of current activities with other countries)
- Introducing new agents and creating awareness
- Improve on sub-regional collaboration

Fiji:

- Funding for maintenance of current facilities/equipment
- Short-term training for technicians (hands-on), e.g. monitoring, rearing, basic identification of BCAs
- Better coordination and consent among groups (e.g. environment, organic movement and farmers)

Vanuatu:

- Funding
- Specific short term training on specific BCAs
- Awareness
- Upgrading of laboratory equipment
- Supply of BCA
- Sub-regional network communication

Solomon Is:

- Funding
- Proper coordination of specialised staff to do work
- Short term training on BCAs
- Awareness

FIGURE 11 The group focusing on issues relating to Melanesia.

2–5 yrs

Solomon Is:

- Biocontrol laboratory (post-entry)
- Long-term training. (trained entomologists/pathologists/taxonomists committed to biocontrol work)
- Updating legislations

New Caledonia:

- Improvement of facilities to handle experiments and introduction of foreign BCAs and promotion of local agents
- Import of foreign BCAs and export of local BCAs
- Updating and cataloguing of species already present in NC
- Promote BC awareness to people (especially agriculture)
- Training of new staff (pathologist/taxonomist/entomologist etc.)

Fiji:

- Long-term scientist training on specific BCAs
- Upgrading facilities
- To handle host-specificity testing within country
- Looking at legislation on biocontrol

Vanuatu

- Funding for current monitoring of BCAs and introducing new agents
- Upgrade current PEQ facility to handle host-specificity testing
- Long-term training of practitioners' (entomologists/pathologists)
- Supply of BCAs on weeds
- More equipment to supply current BCAs
- Updating pest and disease/weeds records

PNG:

- Upgrading of facilities
- Upgrading of Pest List and introduction of BCA of target pests
- Funding of introduction of new BCAs and monitoring of current BCAs
- Biosecurity legislation establishment
- PRAs for introduction of BCAs

5+ yrs

not completed

Co-operating countries and organisations

<24 months:

CABI:

- Invasive species compendium launched June – free info
- Eight chambers of level 3 quarantine + staff available for hire
- 30 staff available for hire
- Some free taxonomy support for PNG and Solomon Is
- Have offices and staff in China, India, Malaysia, Caribbean, Kenya and Pakistan
- Can piggyback on projects in different regions
- Secondments, interns, students

Australia:

- Weed biocontrol training course?
- Mikania project agents
- AUSAID project training for Solomon Islanders in 2010
- ACIAR project in Vanuatu? (Mikania, Mimosa, Parthenium)
- Seven staff available for hire – all aspects covered
- Two quarantine facilities available for hire (could be some limitation on species)
- Review of biocontrol soon – free info
- Provide advice on past projects (hire)
- Offices in: Mexico, USDA
- Good contacts with South Africa and South America
- Piggybacking projects
- Secondments interns, students

USA/Hawaii:

- Good contacts with USDA/ARS and APHIS across USA
- National Pest Diagnostic Network – free taxonomy support for ID of pests from US territories and protectorates (some ability for the rest of the region). Can facilitate identifications needed
- Hawai'i hosting International Symposium on Biological Control of Weeds in September 2011. Could organise Pacific session and try to support participation of Pacific Islanders
- PILN fund participants, EU funds, CTA Netherlands
- USFS has funding (competitive) up to $300,000 for 3 yrs for FSM, Palau, Guam, CNMI, Marshall Is, and America Samoa
- HDOA willing to partner. Funds need to be matched $ for $
- Five staff available for hire in consultation capacities
- Piggybacking on existing projects (e.g. evaluation of agents for Miconia, Clidemia)
- Secondments, interns and students

New Zealand:

- Taxonomy support – some free
- Ten staff available for hire, can provide some time free of charge (e.g. assistance with business case)
- Lincoln quarantine facility available for hire
- Piggybacking on existing projects
- Secondment, intern, students
- ERMA process for deciding if biocontrol agents should be released – used as template, shared, provide independent advice

Organisations (SPC, SPREP, PILN, USP and PII):

SPC

- Biocontrol facility at Suva (heavily used at moment)
- Molecular lab Suva (heavily used at moment)
- Weed laboratory for host-testing Suva (heavily used at moment)
- Plant pathology lab Suva (heavily used at moment)
- Koronivia arthropod collection (needs upgrading)
- Biocontrol workshops?
- Project development, pull things together

USP:

- Plant ID/herbarium
- Marine section

PII:

- Preparation of proposals, project planning, training. Need more coverage on biocontrol of weed training including better business cases

SPREP:

- Prioritisation of issues
- Fundraising assistance
- Project development, pull things together
- Regional workshops

PILN:

- Send people on exchanges for training etc.
- Regional workshops

PestNet:

- Rapid tentative ID and diagnostics with supporting information

Consultants:

- Available for hire/extension (e.g. socioeconomic/business case development)

2–5 yrs

In addition to those listed in <24 months:

- Hawai'i able to do exploration again
- NZ might have pathogen quarantine facility in Auckland available for hire
- Australia will have pathogen quarantine facility in Bogga Road, Queensland
- Better idea of targets and dossiers prepared

5+ yrs

- Another Pacific biocontrol workshop to keep up momentum

5.4 Capacity gap survey report back

Anne Marie collated all the information from the capacity survey into an Excel file and the final draft from the meeting is presented in Appendix 5. It was understood that not all information could be captured at the workshop, but it was important to capture what we could. The resulting document would be a living document that could be further updated after the workshop.

After lunch Anne Marie went through the capacity survey information she had gathered from everyone. This included the facilities, people and general resources available within the group.

5.5 Target weed prioritisation model

Quentin Paynter from Landcare Research presented a model he had developed for a contract on prioritising weeds for biocontrol in Australia. Quentin demonstrated how the model came up with the final values by running 12 Pacific weed examples through it. For each weed target you are asked a series of questions for which a number of answers are given to select from. Each of these answers is assigned a predetermined value. The questions fitted into three categories 1. WEED IMPACT – importance and desirability for control, 2. EFFORT required to obtain and host-range-test biocontrol agents, and 3. BIOCONTROL FEASIBILITY SCORE – predicting the potential impact of biocontrol. The final score is calculated as WEED IMPACT × BIOCONTOL × 1/EFFORT). For a more full explanation refer to Quentin's full presentation on the PII website.

Following this the group split into two to consider weed targets and arthropod targets. The arthropod group left and had a discussion on prioritising arthropod pest targets in the Pacific. Those working with weed targets had a robust discussion on Quentin's model and whether it could be applied to prioritise target weeds in the Pacific for biocontrol. Some of the comments that came out of this discussion are presented here:

Michael Day felt the model could only be applied for individual countries not regionally. He also considered it would be more likely to get funding for projects with individual countries than regional projects.

Another comment from the floor was that you need economic impact data first before you can prioritise targets as sometimes you need to eradicate the weed before it becomes invasive. It was agreed cost–benefit analysis is important, but time-consuming. In the meanwhile it would be good to prioritise weeds and get on with controlling them.

Mic Julien suggested it would be good to put Pacific weeds through Quentin's model if it's not a lot of work. Suggested looking at weeds on a regional scale first and then individual countries. This opened up discussions on the value of regional vs individual countries for prioritising weed targets and if it was the role of the workshop to produce a list for the countries to follow. It is not the intention of the regional workshop to tell countries what to do, but rather to provide individual countries with information, tools and advice to help them make their own decisions.

Concern was expressed about fair representation of all countries in producing a regional list of target priorities, given differences in their populations and size.

The question was asked how valuable is it to prioritise weeds if it doesn't influence what gets worked on. The projects that attract funding are the ones that get worked on.

Warea saw value in using the model to rank the weed targets on the list produced at the meeting as it would identify which weed needs to be controlled in which country. This would identify synergies between countries that shared weed targets so they could apply for funding together. Also, ranking lists are important for getting funding. Funders like to see scientific methods for justifying importance of targets.

There was also concern that conservation and biodiversity specialists were not represented at the workshop and that prioritising targets would therefore be biased towards agricultural weeds. It was pointed out that if you took out the weed importance questions from the model this would remove such bias. It was agreed if weed importance was removed from the model calculations then it would be valuable to put the Pacific weeds through the model for all countries to reveal synergies between countries.

Quentin estimated it would take him two weeks full-time to run the Pacific weeds on the workshop list through the model. Lynley Hayes did a quick calculation for Quentin's time and estimated it would cost around 12,000 NZD to do this. It was agreed at this cost it was worth doing. Anne Marie thought she could get money to do weeds in Micronesia. Warea, Mark B and Konrad were to look into getting funding for the other regions.

The scores produced by the model would only be as good as the information put into it and much of what is needed has not been published. Therefore, to generate reliable scores, Quentin would need people to send him the relevant information for each country, preferably from more than one source so all interested parties were consulted. Konrad, Mic, Anne Marie, Tony-George and Warea agreed to double-check the information put into the model as a further quality control.

As part of the weed list prioritising exercise, the group also scored each weed on the list using Mic Julien's 1–5 categories:

- Biocontrol agents already in region (1A = past successful project, 1B = current project)
- Known agents outside the region
- Utilising current research underway
- Selecting new agents
- No information

Again this information has been incorporated in the final list presented in Appendix 4. Key contacts were also listed for Category 1 weeds.

It was suggested that only weeds in Categories 1 and 2 be assessed via the Landcare Research prioritisation model. However, this list only included weeds important to agriculture. Environmental weeds would need to be included/identified if we were to access the Global Environment Fund (GEF) for any projects to come out of this workshop. Although, it was also pointed out that Fiji and Solomon Is had pulled out of the GEF biocontrol project and only the following 10 countries remained and were therefore eligible for GEF funding (Cook Islands, FSM, Kiribati, Marshall Is, Niue, Palau, PNG, Samoa, Tonga and Vanuatu).

Eight weeds with biocontrol agents were identified as common to both agriculture and environment(e.g. *Miconia calvescens, Mimosa diplotricha, Chromolaena ordorata, Lantana camara, Spathodea campanulata*).

FIGURE 12 Mic and Konrad working on the lists.

Following these discussions a list of the following actions was agreed to:

Actions:

- Quentin Paynter to remove weed importance from the Landcare Research model and run Pacific Island weeds through to rank them.
- Group to check data going into the model: Konrad, Mic, Warea, Mark B, Tony George, Anne Marie, and Alan Tye.
- Anne-Marie, Warea, Mark B and Konrad to source funding for Quentin's work.
- Complete weed list on the wall.
- Identify environmental weeds on list as needed for GEF funding (Note: was completed before 6 p.m.)

- Rank weeds on list using Mic Julien's 1–5 categories (Note: was completed before 6 p.m.).
- Add key contact people for each weed in Mic Julien's categories 1, 2 and 3 (Note: completed before 6 p.m.).

5.6 Results of arthropod biocontrol discussions

Sada reported back on behalf of the arthropod biocontrol breakout group. He reported that they put a table together prioritising biocontrol of arthropod pests using Mic Julien's 1–5 categories to distinguish the different targets. The list is presented in Appendix 6.

Using this information they identified three key areas for research:

- Ants, scales, mealy bugs and aphids
- Fruit fly and fruit piercing moth in relation to trade
- Vegetable integrated pest management (IPM) project

They also had time to put together a brief for one of the projects.

An SPC representative recommended that they also consider including a project on rhinoceros beetle and leaf miner as they had had many requests from numerous countries for this. Sada was going to add this to the table.

5.7 Selection of Pacific Biocontrol Strategy Steering Group Committee

The final task of the day was to form a steering group committee. First it was explained what would be expected of the committee. Typical tasks of the committee would include:

- Take strategy, plans, and actions away after this workshop and make them happen
- Find money and put funding applications together
- Educate and share information

The group needed to consist of representatives from different Pacific regions and organisations, and passionate, committed energetic people to drive initiatives and share the burden during the inevitable challenges.

The following people made themselves available for the committee:

- Wilco Liebregts
- Mark Bonin (PILN rep)
- Alan Tye (SPREP rep) Note, Alan was unable to attend the meeting but had agreed beforehand to this role.
- Warea Orapa (SPC rep)
- Souad Boudjelas(PII rep)
- Christian Mille (New Caledonia)

- Billy Enosa (Polynesia)
- Tony-George Gunua (Melanesia)
- Konrad Engelberger (Micronesia)
- Quentin Paynter/Lynley Hayes/Sarah Dodd (NZ)
- Dick Shaw (CABI)
- Tracy Johnson (USA/Hawai'i)
- Darcy Oishi (Hawai'i)
- Mic Julien (Australia)

The first committee meeting was scheduled for lunchtime Day Three (Wednesday 18 November). Minutes of this meeting are presented in Appendix 7.

5.8 Feedback Day Two

Michele again asked for some feedback about how the day had gone:

THINGS DOING WELL: sharing knowledge in arthropod session, got a lot done with so many different people/countries/organisations, good to get co-ordinating committee sorted so easily, enjoyed Carolyn's birthday cake.

THINGS TO CHANGE: arthropod list to be expanded, not discussing other pests such as vertebrates and plant pathogens – need to keep on radar.

6 Day Three
Wednesday 18 November

6.1 Introduction to Day Three

Progress so far:

- Reviewed and updated projects
- Created list of lessons learnt
- Anne Marie's capacity survey completed – with list of current practitioners
- Identified priority target weeds and arthropods and assessed different ranking systems

Today will cover:

- What are the barriers?
- Communication, how can we improve?
- Identify funding opportunities
- Afternoon, pull all together and come up with a regional plan

At this point a poem written by one of the participants at the workshop was read out:

The Weeds Tale
By Peter Maddison

There once was a weed called mile-a-minute
You may have heard about its odd growth habit
It grows all over trees and fences
Until the scientists probed its defences
They searched for agents near and far
And drank a beer at many a bar
Warea decided the answer was rust
And so the weed's aggression was bust
Three cheers for biocontrol!

6.2 Barriers to biocontrol

Following the introduction, the participants were split into smaller groups and each asked to come up with a list of key barriers to biocontrol projects in the Pacific. A combination of these lists is presented below:

- Lack of resources (facilities, human, finance – funding often determines projects, not other way around)
- Social
- Local and policymakers
- Infrastructure/transport
- Communication (phone/slow Internet)
- Lack of information on biocontrol, rearing agents, equipment
- Lack of training/education/staff commitment
- Restrictive regulatory/quarantine laws
- Lack of protocols in place
- Political interference through lack of understanding and trust
- Lack of public awareness
- Negative perception from failures of the past
- Lack of awareness of the numerous success stories
- Lack of taxonomy resources
- Poor regional coordination
- Distance between countries
- Lack of organisational coordination to avoid duplication
- Conflicts of interest, e.g. lack of resolution between agriculture vs environmentalists
- Lack of support of greater good vs individual needs

6.3 Solutions to barriers

Each group was then asked to provide a list of tasks to be considered by the Biocontrol Steering Group Committee to overcome these barriers.

- Set up an independent advisory group (~6 people) to review biocontrol agent release applications for all Pacific Islands, to provide peer review advice. Must be recognised, trusted individuals and there would need to be some consistency in the group membership. Must meet regularly to review – (travel vs telecommunication?). Should meet regularly with Ministers and Heads of Agriculture and Forestry (could attend 2-yearly meetings).Members should include range of specialists (e.g. entomologist, pathologist, botanist, quarantine, communications, economics, systematists)
- Raise public awareness
- Educate local communities with emphasis on good versus bad
- Identify champions in local communities
- Local radio programmes, TV documentaries, videos, news items
- Target groups, e.g. youth, school curriculum, women, church groups, field days
- Create outreach materials – posters, videos, audiovisual materials, buttons, caps
- Access to policymakers
- Have regular presence at regional meetings to keep biocontrol on the radar with policy makers
- Identify key meetings to attend (make a list, e.g. CRGA, PPPO, SPC, SPREP, MoAFs, farmer organisations)
- Convince policymakers with business cases
- Engage social science to capture impact data at village level – examples of adding real value to lives
- Develop a common biocontrol message that can be delivered at any meeting – preferably using Pacific examples with cost-benefit data available. (e.g. Anne Marie strawberry guava)
- Co-ordinating committee need to choose a name carefully to get best overall reception
- Regulatory framework
- Involve regulatory officials in projects early on – cultivate contacts
- Provide independent expert advice to regulator – (e.g. advisory group)
- Influence regulators (e.g. Animal and Plant Health Inspection Service (APHIS), US Fish and Wildlife Service (USFWS), RISC and other regional policy groups)
- Work with National Science Foundation (NSF), NIFA, GISAC programme leaders
- Work with local Environmental Protection Agency (EPA) officials
- Participate in legislative actions where appropriate

6.4 Communicating biocontrol

Following morning tea, the participants were split into sub-regional groups once again and given the task of identifying ways to increase communication of biocontrol in each of their sub-regions.

Polynesia:

- Share project progress news such as biocontrol releases, new agents etc., through group emails, but keep small
- Develop web-based tool for communication for biocontrol group (action for steering group committee) with open forum page, but restricted access to subscribers (e.g. like PestNet and Wiki sites) or set up though Yahoo or Google groups for free. Customised page with restricted access would require $$
- Increase internet connection speeds – downloading big files is an issue. Better resources = quicker responses
- Regular quarterly conferencing e.g. Skype (Darcy to look into)

Melanesia:

- Identified contact person in each country responsible for disseminating information: Fiji – Bal Swami, New Caledonia – Bruno Gatimel, PNG – Tony George Gunua, Vanuatu – Sylverio Bule, Solomon Is – Helen /John Fasi
- Annual/Biannual meeting of contacts to discuss issues
- Use existing network to send emails (maybe 6-monthly) to give updates of activities
- Training and exchange of scientists and personnel within sub-regions on new and existing biocontrol programmes

Micronesia:

- Better regional coordination
- Ag directors
- RISC – need to put biocontrol on agenda
- Need better connection to College system networks and Government agencies. Biocontrol course research, teaching, training. Colleges meet, could coordinate land grant – put BC on agenda. Contact Lee Yudin- UOG (AML)
- Improve in-country communication and co-operation
- Need Micronesian biocontrol focal point person in SPC. Replacement for Konrad
- Better coordination of US Federal agencies in region (Anne Marie to instigate)
- Biocontrol representation on Regional Invasive Species Council (RISC)
- SPC regional PPPO meeting
- IOBC – participate in larger groups making use of existing contacts
- PestNet for information
- Micronesian biocontrol steering group. All 10 biocontrol practitioners in Micronesia

- Internet- based working group for all regions (Aubrey)
- Conservation education $$ – USFS regional application
- Regional/territorial Foresters(Anne Marie)

Co-operative countries and organisations:

- Produce regular newsletter, e.g. NZ's 'What's New in Biocontrol?' Quarterly consisting of 16 pages once a year and 8 pages 3 times a year. Reports on progress of biocontrol projects. Sent to scientists, regional councils, government agencies and other interested parties
- Website for Biocontrol in the Pacific. Drop box software attached to website. Decide what the purpose of website is and build from there. Servers need lots of updating and maintenance – easier to put up links. Use existing websites, e.g. PILN and SPC – keep regional level. Warea can host websites easily

6.5 Key communication messages

Sub-regional groups were then asked to come up with three key messages for biocontrol in the Pacific and to identify the resources they had or needed to get these out there.

Polynesia (Figure 13):

- Biocontrol benefits health of the environment and people
- Local TV and radio programmes discuss health – add biocontrol
- Tailor message and deliver to specific audiences
- Follow outreach with school competitions – create poem or song to deliver message

FIGURE 13 The group from Polynesia present their ideas.

- Biocontrol provides solutions that are sustainable in long term
- Person to person, community outreach (e.g. women's and youth groups)
- Community meetings, career days, farmer field days
- Biocontrol is founded on the concept of host-specificity
- Demonstrate with familiar examples (e.g. rhinocerous beetle, coconut scale)
- Graphic tools, photos before and after
- Inform public on how target organisms affect food security and cash income (economics) and environment
- Biocontrol is safe (with present tools) and cost effective
- Success stories of past biocontrol projects, and the impacts of proposed biocontrol agent

Resources to deliver messages:

Have:

- Radio talk-back shows
- Posters and brochures (in different dialects)
- Open-days and field days/community level awareness/compulsory student visits.

Need:

- Funds for production of posters/pamphlets/distribution
- Identify target audiences and prepare relevant messages
- Good networking with existing media
- Promotional goodies, e.g. T-shirts/bags/stickers

Micronesia:

- Biocontrol is a safe, environmentally friendly, long term solution and cost effective means to control certain invasive species
- Biocontrol success stories, e.g. Mimosa, papaya mealybug, Chromolaena
- Contact points for more information.

Resources to deliver messages:

Have:

- Cooperative extension
- Local media, government agencies
- NGOs
- Invasive species task force

Need:

- Funding
- People with expertise in media/public communication
- Legislative briefs of biocontrol activities

Co-operating countries and organisations:

- It's needed (doing nothing will only make it worse), it's safe (agents are host specific), it works!

  Resources to deliver messages:

  Have:

  - Examples of success
  - SPC/PII/SPREP/PILN/IOBC
  - Web pages/pamphlets
  - Expertise/knowledge
  - Reviews and papers

  Need

  - Community-level communication
  - Better coordination
  - Socio-economics
  - Country prioritisation
  - Repeat exposure
  - Biocontrol in school curriculum – educate next generation, flow on to parents
  - Communication plan and evaluation of impact

The groups then reported back and ideas for improving communication were discussed. Additional ideas that came out of the discussions included:

- Include communities in developing a communication plan so they feel involved and have ownership
- Need specific localised communication on regular basis
- Missed opportunities – sell biocontrol as it happens e.g. scale insect controlled quickly and effectively but not widely advertised and now no-longer an issue – so no one talking about it anymore
- Need to communicate key messages to all segments of the community in their native language – note Melanesia has over 100 languages so would be a challenge. But important to deliver in native language at community level
- Farmers groups, local communities need to express their need for biocontrol to the government

- Need to listen to the community as well, e.g. in Cook Islands, broom weed (Sida) is not considered a problem, but rather an attractive plant in amongst crops. Introduction of an ugly larva on an attractive weed may not be received well by locals.

6.6 Actions to improve communication:

A list of actions for the co-ordinating committee to consider was produced:

- Investigate website/list server
- HEAR website –Anne Marie to talk to them about setting up list servers
- Liaise with PILN

6.7 First meeting of the Pacific Biocontrol Strategy Coordination Committee

The members of the committee meet over lunch. The minutes of the meeting are presented in Appendix 7.

6.8 Identify funding opportunities

Following lunch a list of potential funders was collated from the group (Figure 14):

- ACIAR
- USDA-TSTAR
- USDA-APHIS
- USDA-NIFA
- USDA-FS
- USDA-WSARE
- USDA-NRCS
- French Polynesia Fund
- Dumont foundation/ FRST (NZ/French bilateral funds)
- EU
- CEPF
- GTZ
- AUSAID
- NZAID
- IFAD
- FEAST (French Australian collaboration)
- FAO
- GEF

- UNDP/SPREP
- Taiwanese/Pacific fund
- World bank – country loans for development
- CFC (commodity fund)

See Appendix 8 for more details.

In addition it was also noted that PII and the steering group committee can help prepare proposals for funders. SPREP can also help with sourcing funds. The USDA runs a grant writing workshop in Guam in Dec/Jan for US affiliated countries. Darcy offered to organise a working group to put together a database of funding sources and their criteria etc.

FIGURE 14 Richard (ACIAR) giving advice on what is needed in funding applications.

6.9 Strategic Plan

The following research projects were proposed:

Optimising biocontrol in the Pacific (Mic)

- Moving existing agents from one country to another. Low-cost activity
- Need to employ someone to coordinate. Mic Julien happy to generate project, but not lead it. Mark B. and Reddy offered to help Mic with weeds and arthropods respectively
- Application to AUSAID in 6 months (June 2010)
- Need to identify countries involved so they can approach their authorities about agent releasing protocols

- Timeframe for project, 2 years in the short term
- Leverage to be sought from US affiliates with complementary proposal to fund their sub-region (Anne Marie)

New Spathodea project (Warea)

- DNA studies on weed populations in Fiji and PNG – but want to expand
- Application to be prepared for ACIAR funding in 3–6 months (June 2010)
- Wilco's funding proposal results will known in December. Modelling of biocontrol (European proposal put in with PI associates).

Merremia DNA study to determine origin and native range (Lynley, Bill, Mark B.)

- Lynley to look into how much it would cost for Landcare Research to resolve this key question
- Would need countries to send samples to NZ to keep cost down
- Kew Garden has samples in herbarium
- Possible funding GEF, CEPF, TNC

IPM of vegetables (Muni)

- SPC led
- Get draft proposal to SPC in 3 months
- USDA-ARS may also be interested
- NZAID support participation, PILN support travel exchanges, also US funds

Update arthropod (or all) pest list (Christian)

- Arthropod book is outdated and needs revising
- SPC has database of current pest lists – but not published
- Not a priority for SPC but could fund a consultant

Update Waterhouse biocontrol guidelines

- SPC to fund consultant to complete in 12 months

Eurythrina gall wasp (Darcy, Anne-Marie, Greg Sherley, Alan Tye etc.)

- Collaboration on a grant
- Training in Hawai'i, Samoa, Fiji, American Samoa, PNG, Vanuatu, NC and Tonga
- Juliana to have scoped by Jan 2010

Ants/hemiptera (Ross) (Figure 15)

FIGURE 15 Ross suggested a project on ants/hemiptera.

- Alex Brook CABI, Hawai'i
- 6-month time frame to figure out what doing and how
- 1–2 years timeframe for project
- Tracy to send Ross information on US Department of Defence funding
- Herve to scope French Polynesia Fund
- Australian group applying for funding to work on parasitoids of invasive ant species, should link in with PI
- Pacific ant prevention program – SPC-run. Have all contacts, representative should be involved
- Ross/Warea to help Darcy check capacity
- Coffee screen project – Dick to provide support for removing ants

Fruit flies and fruit piercing moth (Muni)

- SPC led
- Proposal to be developed in 6 months

Hedychium garderianum (wild ginger)(Lynley/Dick)

- Piggyback on existing project. Host range testing for PI at same time as testing for NZ
- Problem in Fiji native forests and PNG
- Funding sources might be TNC and CEPF

Biocontrol of melastomes (Tracy Johnson)

- Non-target testing of potential Miconia/Clidemia biocontrol agents on native melastomes
- Need a complete list of native melastomes in the Pacific
- Coordinate search for list

6.10 Summing up and farewells

The room was rearranged so that everyone was sitting in a large circle facing each other.

The organisers were congratulated and thanked for all their hard work. Thank you gifts were given. Some reminders were given to participants:

- It was reiterated that the weeds and arthropod lists are works in progress. Arthropod list to be added to once people return home and have access to relevant information. Sada responsible for coordinating this. Mic Julien and Warea were responsible for producing the final weed list. Lists will be sent to countries not present at workshop to get their input.

- Workshop report is due to funders (USFS, USSD, NZAID and CEPF) before Christmas. Sarah Dodd to distribute first draft for comments by end of Dec 1.
- Participants need to send information on what they got out of the workshop and how they are going to implement it back to their country – information required for NZAID report.
- Need authors to send electronic copies of posters for the report and CD ROM proceedings.
- Need finalised weed and arthropod lists for report (Warea, Mic and Sada).
- Need minutes of the first steering group committee meeting for report (Mic Julien).
- Need list of potential project funders and criteria from Darcy for report.

Note a list of all the actions agreed at this workshop is included in Appendix 9.

Participants were then each asked to share one thing they would tell people back home about the workshop. One by one each shared what they had gotten out of the workshop.

Participants were then given time to fill out feedback forms on what they thought of the workshop. Results of this survey are summarised in Appendix 10.

Emil Adams from SPC announced he was going to post two media releases on the SPC website (www.spc.int). Articles are also presented in Appendix 11.

The workshop was officially closed.

FIGURE 16 The final wrap-up.

7 Visit to MAF BNZ and Landcare Research

A group of nine people, who were not catching early flights, took up the offer to visit MAF Biosecurity New Zealand (BNZ) and Landcare Research facilities at Tamaki (Figure 17).

The itinerary for the visit was:

9.15 Lalith to show them the MAF BNZ labs

10.15 Morning tea

10.30 Trevor Crosby to show them the New Zealand arthropod collection

11.30 Peter Johnson to show them the New Zealand fungal herbarium

12.15 Sarah Dodd to show them the culture collection and labs

12.30 Some return to hotel, others stay on to look at collections, view building, talk with others.

FIGURE 17 Viewing the molecular lab.

8 Acknowledgements

This workshop would not have been possible without the generous funding provided by the Critical Ecosystem Partnership Fund, Hawai'i Invasive Species Council, Landcare Research, NZAID, USDA Forest Service, and United States State Department. This workshop would also not have happened without the support provided by the Pacific Invasives Initiative, Pacific Invasives Learning Network, Secretariat for the Pacific Community, and The South Pacific Regional Environment Programme. Funding provided by the Australian Centre for International Agricultural Research allowed two additional participants to attend.

Thanks to Michele Frank and Harley Spence, of Agenda to Action, for facilitating the workshop and making sure we stayed on track and achieved our desired outcomes. Thanks also to Carolyn Lewis, our workshop organiser, who worked tirelessly behind the scenes to ensure all the logistics ran smoothly.

Thanks to all the participants, who entered heart and soul into the workshop, ensuring we had an enjoyable and productive time.

Finally thanks to the other members of the organising committee: Anne Marie LaRosa, Warea Orapa, Tracy Johnson, Mark Bonin, Alan Tye and Souad Boudjelas. It was a big task but we finally did it!

Appendix 1

List of participants

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Workshop Organiser				
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Appendix 2

List of poster presentations

Brooks S, Raboin E, Johnson T 2009. *Host choice by* Cryptorhynchus melastomae*, a stem-boring weevil for biocontrol of miconia.*

Johnson MT, Denslow J, Uowolo A, Raboin E, Fraiola H 2009. *Impacts of strawberry guava and its biocontrol.*

Moore A, Miller R, Marler T 2009. *Cycas micronesica on Guam: an ongoing struggle against invasive pests.*

Munniappan R 2009. *Invasion of papaya mealybug in Asia.*

Munniappan R, Steed F 2009. *IPM package for vegetable production improves live in the tropics.*

Oishi DE 2009. *Hawaii Department of Agriculture biological control: past, present and future.*

Orapa W, Day M, Tunabuna A 2009. *Biological control of mile-a-minute weed in Fiji and PNG.*

Prasad S, Lal SN 2009. *Testing of oryctes virus (OrV) in rhinoceros beetle guts.*

Route A, Tenorio J, Nandwani D, Muniappan R, Reddy GVP 2009. *Invasive plant species in the Commonwealth of the Northern Marianas Islands.*

Appendix 3

Key references circulated to participants before the workshop

Dovey L, Orapa W, Randall S 2004. *The need to build biological control capacity in the Pacific*. In: Proceedings of the XI International Symposium on Biological Control of Weeds (eds Cullen JM, Briese DT, Kriticos DJ, Lonsdale WM, Morin L, Scott JK), pp36–41.

FAO Code of Conduct for the import and release of exotic biological control agents. http://www.fao.org/docrep/x5585E/x5585e0i.htm (accessed November 2009).

Julien MH, Scott JK, Orapa W, Paynter Q 2007. *History, opportunities and challenges for bioclogical control in Australia, New Zealand and the Pacific Islands*. Crop Protection 26:255–265.

Waterhouse DF 1997. *Guidelines for biological control projects in the Pacific*. Information Document No 57. South Pacific Commission, 34p.

Appendix 4

List of priority weeds

Table 1 Combined list.

		Agricultural weed	Environmental weed	CONTACT PEOPLE	No. of PICTs ranking weed in top 10 list	No. of PICTs ranking weed in top in 2004	Australia	New Zealand	Palau	CNMI	Guam
Acacia farnesiana (Fabaceae)	5	A	E		1	3	C				
Acacia spp. (A. confusa, A.mearnsii, A.melanoxylon, A.spirobis) (Fabaceae)	5					A mearnsii and A. melanoxylon were targets in S Africa					
Adenanthera pavonina (Fabaceae)	5		E								
Ageratum conyzoides (Asteraceae)	5	A			2	1	C				
Albizia chinensis (Fabaceae)	5	A	E		nr	2					
Albizia spp. (A. lebbeck, A. saman = Samanea saman) (Fabaceae)	5										
Antignon leptopus (Polygonaceae)	5	A	E		4	4	C		B	B	B
Ardisia elliptica (Myrsinaceae)	5										
Bidens pilosa (Asteraceae)	5	A			4	1	C			B	B
Broussonnetia papyrifera (Moraceae)	5	A	E		1	1					
Cardiospermum grandiflorum (Sapindaceae)	4	A		Julien	1	1	B				
Cassytha filiformis (Cassythaceae)	5	A			nr	2					
Cecropia spp. (C. obtusifolia, C. peltata) (Cecropiaceae)	5										
Cenchrus echinatus	5	A									
Cestrum spp. (C. diurnum + C. nocturnum) (Solanaceae)	5						C				
Chromolaena odorata (Asteraceae)	1A	A	E	Day, Muni Warea, Konrad	4	4	C		A	A	A
Clerodendrum chinensis (Verbenacaeae)	4	A	E	Julien	2	5	C			C	C
Clerodendrum quadriloculare (Verbenaceae)	5	A	E	Warea	2	4					
Clerodendrum japonica (Verbenaceae)	5										

Biocontrol Project Feasibility Ranking: 1 = known agents in the Pacific; 2 = known agents outside the Pacific; 3 = potential to utilise current research; 4 = searching for new agents; 5 = no information available. Red = agricultural weed, Black = environmental weed. A = Biological control project completed or underway, B = Biocontrol needed (future project), C = Biocontrol not needed, Blank = don't have the weed.

Federated States of Micronesia	Republic of Marshall Islandsl	Hawaii	French Polynesia	American Samoa	Samo	Cook Is	Niue	Tonga	Fiji	Vanuatu	Kiribati	New Cal	Solomon Islands	PNG	Tuvulu	Tokelau	Pitcairn
a. Substantial control of A melanoxylon with a weevil. Unknown impact with another weevil on A mearnsii (Olckers & Hill 1999)																	
B					B		B	C		C			C	C			
B			C	C	C	C			C					C			
						B											
												B					
A														A			
B			B	C	B		B		B	B			B	B			

		Agricultural weed	Environmental weed	CONTACT PEOPLE	No. of PICTs ranking weed in top 10 list	No. of PICTs ranking weed in top in 2004	Australia	New Zealand	Palau	CNMI	Guam
Clerodendurm paniculatum	5	A	E						B	C	C
Clidermia hirta (Melastomataceae)	1A	A	E	Tracy, Warea	3	2	C		B		
Coccinia grandis (Curcubitaceae)	1A	A	E	Muni, Reddy	2	4				A	A
Commelina benghalensis (Commelinaceae)	5	A	E		nr	2				C	C
Costus speciosus (Zingeberaceae)	5		E		1	1			B		
Cyperus rotundus (Cyperaceae)	5	A			10	6	C	C	B		
Eichhornia crassipes (Pontederiaceae)	1A	A	E	Julien, Warea	3	1	A				
Epipremnum							C				
Euphorbia hirta (Euphorbiaceae)	5	A			nr	2	B				
Hedychium spp. (H.coronarium, H. flavescens, H.gardnerianum) (Zingerberaceae)	4		E	Shaw, Hayes			C	A			
Imperata cylindrica (Poaceae)	5	A	E		2	2	C				
Ischaemum spp. (I. polystachyum var. chordatum, I. timorense) (Poaceae)	5										
Kyllingia polyphylla (Cyperaceae)	5	A			3	2				C	C
Lantana camara (Verbenaceae)	1A	A	E	Day, Tracy, Darcy, Ellison, Hayes	3	5	A	A	C	A	A
Leucaena leucocephala (Fabaceae)	5	A	E				C				
Melinis minutiflora (Poaceae)	5						C				
Meremia tuberosa	5	A	E						B	C	C
Merremia peltata (Convolvulaceae)	5	A	E		10	11	C		B		
Miconia calvescens (Melastomataceae)	1B	A	E	Tracy, Jean-Yves	1	1	B				
Mikania micrantha (Asteraceae)	1B	A	E	Day Warea, Ellison	12	10	C		B	B	B
Mimosa diplotricha (Fabaceae)	1A	A	E	Day, Konrad, Warea, Reddy, Muni	8	8	A		C	A	A
Mimosa pigra	A	A	E	Julien			A				
Mimosa pudica (Fabaceae)	5	A			7	1	C		B	B	B
Occimum grattissimum (Lamiaceae)	5	A			nr	2					
Panicum spp. (P. maximum + P. repens)	5						C				
Paraserianthes (Albizia) *falcataria* (Fabaceae)	5										

Federated States of Micronesia	Republic of Marshall Islands	Hawaii	French Polynesia	American Samoa	Samo	Cook Is	Niue	Tonga	Fiji	Vanuatu	Kiribati	New Cal	Solomon Islands	PNG	Tuvulu	Tokelau	Pitcairn
B					B				C	C			C	C			
B		A		C	B				A				B	B			
		A			B				B	B			B	B	C		
								B					B	B			
B									C	C			C				
B			C	C	B	C			B			B		B			
		C	C		B				A	A		B		A			
		B					B		B					B			
B			B		B				B				C	C			
A		c?	C	C	B	A	A	A	C	A		A		C			
B					B		B	B	C				C				
B			C	C	B				B	B		C		B			
		A	A									A					
B				C	C	C			A			B		A			
A			B	C	A	A	A	A	C	B		B		A			
														B			
B					B	B	B	B	B	B		B	B	B			

		Agricultural weed	Environmental weed	CONTACT PEOPLE	No. of PICTs ranking weed in top 10 list	No. of PICTs ranking weed in top in 2004	Australia	New Zealand	Palau	CNMI	Guam
Parthenium hysterophorus (Asteraceae)	1A	A		Day	3	3	A				
Paspalum spp. (P.conjugatum, P. distichum, P. urveillei) (Poaceae)	5	A	E				C				
Passiflora spp. (P. foetida, P. laurifolia, P .ligularis, P.tripartata, P.quadrangularis, P. rubra) (Passifloraceae)	3		E	Lynley			B				
Pennisetum spp. (P. clandestinum, P. polystachyon, P. purpureu, P.setaceum) (Poaceae)	5	A	E				B				
Piper aduncum (Piperaceae)	5	A	E	Warea			C			C	C
Piper auritum (Piperaceae)	5	A	E		1	3					
Psidium spp. (P.guajava + P. cattleianum) (Myrtaceae)	3	A	E	Tracy			C				
Rottboelia cochinchinensis (Poaceae)	2	A		Ellison	1	1	C				
Rubus spp. (R. argutus, R.ellipticus, R.glaucus, R.moluccanus, R. nivalis, R, rosifolius) (Rosaceae)	4		E	Tracy							
Salvinia molesta (Salviniacaeae)	1A	A	E	Julien, Warea			A			C	C
Senna tora (Fabaceae)	5	A			2	1	C			C	C
Sida acuta (Malvaceae)	1A	A		Warea, Kaile,	nr	2	A				B
Sida rhombifolia (Malvaceae)	1A	A		Warea, Kaile, Kuniata	7	6	A			B	B
Solanum torvum (Solanaceae)	5	A			5	3	B			C	C
Sorghum halepense (Poaceae)	4	A	E		1	1	C				
Sorghum sudanense (Poaceae)	5		E				C				
Spathodea campanulata (Bignoniaceae)	4	A	E	Warea	5	7	B			C	C
Sphagneticola trilobata (Asteraceae)	5	A	E		5	8	B		C		
Stachytarpheta jamaicensis (Verbenaceae)	5	A	E				C			B	B
Stachytarpheta urticifolia (Verbenaceae)	5	A	E		3	2	C			B	B
Syzygium spp. (S. cumini, S. floribundum, S. jambos) (Myrtaceae)	5										
Tecoma stans (Bignoniaceae) Weedy in Brazil. No native range surveys done	4	A	E	Warea			C				
Xanthium strumarium (Asteraceae)	2	A		Day	nr	2	A				C

Federated States of Micronesia	Republic of Marshall IslandsI	Hawaii	French Polynesia	American Samoa	Samo	Cook Is	Niue	Tonga	Fiji	Vanuatu	Kiribati	New Cal	Solomon Islands	PNG	Tuvulu	Tokelau	Pitcairn
								C	B	B		B	B	B			
														5			
		B	C			C			A			B		A			
					B			B	B	B				C			
B					B		B		A	A	C		B	A			
			B	C	B		C		A	A		B	B	A			
					B				B	B			C	C			
B		B	B		B	B	B	B	A	B			B	A			
B			C		C				B	B		C		B			
B				C	B	C	B	B	B	B	C	B	B	B			
B				C	B	C	B	B	B	B	C	B	B	B			
								C	B			C		B			

TABLE 2 An environmental-sector ranked list of 33 most significant invasive plant taxa by order of the number of PICTs where the plant is considered to be dominant (D), followed by the number of PICTs where the plant is considered to be moderate (M), and the sum of these (D+M) (Meyer 2000). Information in this table excludes PNG, Solomon Islands and New Zealand but includes Hawai'i (Orapa in press).

Plant name and family	D	M	D+M
Lantana camara (Verbenaceae)	14	1	15
Leucaena leucocephala (Fabaceae)	13	3	16
Pennisetum spp. (P. clandestinum, P. polystachyon, P. purpureu, P.setaceum) (Poaceae)	11	2	13
Psidium spp. (P.guajava + P. cattleianum) (Myrtaceae)	6+4	5+1	16
Mikania micrantha (Asteraceae)	8	0	8
Paspalum spp. (P.conjugatum, P. distichum, P. urveillei) (Poaceae)	7	6	13
Mimosa diplotricha (Fabaceae)	7	2	9
Merremia peltata (Convolvulaceae)	7	0	7
Adenanthera pavonina (Fabaceae)	5	2	7
Clerodendrum spp. (C.chinensis, C.japonica, C.paniculatum, C.quadriloculare) (Verbenaceae)	5	2	7
Passiflora spp. (P. foetida, P. laurifolia, P .ligularis, P.tripartata, P.quadrangularis, P. rubra) (Passifloraceae)	4	10	14
Rubus spp. (R. argutus, R.ellipticus, R.glaucus, R.moluccanus, R. nivalis, R, rosifolius) (Rosaceae)	4	6	10
Syzygium spp. (S. cumini, S. floribundum, S. jambos) (Myrtaceae)	4	4	8
Panicum spp. (P. maximum + P. repens)	3+1	3+0	7
Eichhornia crassipes (Pontederiaceae)	4	3	7
Paraserianthes (Albizia) falcataria (Fabaceae)	4	2	6
Clidermia hirta (Melastomataceae)	4	0	4
Acacia spp. (A. confusa, A. farnesiana, A.mearnsii, A.melanoxylon, A.spirobis) (Fabaceae)	3	5	8
Spathodea campanulata (Bignoniaceae)	3	5	8
Hedychium spp. (H.coronarium, H. flavescens, H.gardnerianum) (Zingerberaceae)	3	4	7
Sphagneticola trilobata (Asteraceae)	3	4	7
Melinis minutiflora (Poaceae)	3	4	7
Sorghum spp. (S. halepense + S. sudanense) (Poaceae)	2+1	1+1	5
Chromolaena odorata (Asteraceae)	3	1	4
Ardisia elliptica (Myrsinaceae)	3	0	3
Ischaemum spp. (I. polystachyum var. chordatum, I. timorense) (Poaceae)	3	0	3

Plant name and family	D	M	D+M
*Albizia spp. (A.chinensis, A. lebbeck, A. saman = Samanea saman) (*Fabaceae*)*	2	6	8
*Cestrum spp. (C. diurnum + C. nocturnum) (*Solanaceae*)*	2+0	2+1	5
*Cecropia spp. (C. obtusifolia, C. peltata) (*Cecropiaceae*)*	2	1	3
*Coccinia grandis (*Curcubitaceae*)*	2	1	3
*Imperata cylindrica (*Poaceae*)*	2	0	2
*Tecoma stans (*Bignoniaceae*)*	1	4	5
*Stachytarpheta spp. (S. urticifolia + S. jamaicensis) (*Verbenaceae*)*	1+0	7+1	9

TABLE 3 List of weeds for which biocontrol agents are already available in the Pacific.

Biocontrol Project Feasibility Ranking: 1 = known agents in the Pacific; 2 = known agents outside the Pacific; 3 = utilising current research; 4 = selecting new agents; 5 = No Information available. A = Biological control project completed or underway, B = Biocontrol needed (future project), C = Biocontrol not needed, Blank = don't have the weed.

Plant Species *Note: Weed Names in red or with a red E in column D are species that were listed as important invasive plants at the SPREP organised meeting in 2000*		Ag	Env	CONTACT PERSONS	No. of PICTs ranking weed in top 10 list	No. of PICTs ranking weed in top in 2004	Aus	NZ	Palau	CNMI
Acacia farnesiana (Fabaceae)	5	A	E		1	3				
Chromolaena odorata (Asteraceae)	1A	A	E	Day, Muni Warea, Konrad	4	4	C		A	A
Clidermia hirta (Melastomataceae)	1A	A	E	Tracy, Warea	3	2	C		B	
Coccinia grandis (Curcubitaceae)	1A	A	E	Muni, Reddy	2	4				A
Eichhornia crassipes (Pontederiaceae)	1A	A	E	Julien, Warea	3	1	A			
Lantana camara (Verbenaceae)	1A	A	E	Day, Tracy, Darcy, Ellison, Hayes	3	5	A	A	C	A
Mimosa diplotricha (Fabaceae)	1A	A	E	Day, Konrad, Warea, Reddy, Muni	8	8	A		C	A
Parthenium hysterophorus (Asteraceae)	1A	A		Day	3	3	A			
Salvinia molesta (Salviniacaeae)	1A	A	E	Julien, Warea			A			C
Sida acuta (Malvaceae)	1A	A		Warea, Kaile,	nr	2	A			
Sida rhombifolia (Malvaceae)	1A	A		Warea, Kaile, Kuniata	7	6	A			B

	Guam	FSM	RMI	Hawaii	FP	Am. Samoa	Samo	Cook Is	Niue	Tonga	Fiji	Vanuatu	Kiribati	New Cal	Sol	PNG	Tuv	Tokelau	Pitcairn
	A	A												B		A			
		B		A		C	B				A				B	B			
	A			A			B				B	B			B	B	C		
				C	C		B				B	B		B		A			
	A	A		c?	C	C	B	A	A	A	C	A		A		C			
	A	A			B	C	A	A	A	A	C	B		B		A			
	C			B	C			C			A			B		A			
	B	B					B		B		A	A	C		B	A			
	B				B	C	B		C		A	A		B	B	A			

Appendix 5

Results of capacity survey

SURVEY OF BIOCONTROL CAPACITY IN THE PACIFIC – 2009 – Pacific Countries Worksheet

CURRENT TOP 5–10 TARGETS FOR BIOCONTROL: ALL TAXA (WEEDS, INSECT PESTS, PATHOGEN		
COUNTRY:	TARGETS	
FSM	*Chromolaena odorata*	Pohnpei, Chuuk, Yap, Kosrae
	Mikania micrantha	Kosrae, Yap?
	Clidemia hirta	Pohnpei
Hawaii	*Psidium callleianum*	*Rubus ellipticus*
	Miconia calvescens	*Salsola tragus*
	Pennisetum setaceum	*Pseudalacapsis pentagona* (white peach scale)
	Tibouchina herbacea	Clidemia hirta
	Senecio madagascarensis	
	Quadristicus erythrinae (Eyrthrina gall wasp)	
Niue	*Sida acuta*	
	Merremia tuberosa (woodrose)	
	Wedelia trilobata	
	Merremia peltata	
	Stachytarphaeta urticifolia	
	Nematodes	
Samoa	African Tulip	Scales
	Clerodendrum (purple leaf tree)	Mealybugs
	Vao lipiti	Ants
	Phytopthora	Coconut rhino beetle
		Giant African snail
Fiji	*Spathodea tulipifera*	Bean pod borer
	Wedelia	Susmoa
	Mission grass	*Nilapara vada* – Ria plant hopper
	Clerodendrum chinensis	Coconut mealy bug – Nephaecocus nephae
	Noogoora burr	Ginger nematode

SURVEY OF BIOCONTROL CAPACITY IN THE PACIFIC – 2009 – Summary of Capacity

INFRASTRUCTURE: BIOCONTROL FACILITIES IN PACIFIC COUNTRIES						
Country	Facility type	Certified?	Location	Size/capacity	Age/ condition	# agents in facility
Guam	2 room quarantine facility	Yes	UOG Campus, Mangilao Guam	Two 10ftX10ft rooms	Old house from 1970s, refurbished about 2000	
Cook Islands	None, we lost our facility a few years ago due to land issues					
French Polynesia	Rearing room	No	TAHITI	25 m^2	30	2
New Caledonia	Laboratory	No	La Foa	3 rearing rooms	1994, good condition	4
	"Biofabrique"	No	Mont-Dore	3 rearing rooms (3x7 m^2) and 1 associated greenhouse (75 m^2)	New	2
	Laboratory and green house (IRD research center)	No	Noumea	2 rearing rooms, Greenhouse (30 m^2)		2
CNMI	Research and Extension	No	Saipan	20'x30' Entomology lab/	3 yrs/good	3
American Samoa	Ento/Plant Path lab		ASCC	700m2 each	good	0
FSM	Small house	No	Kolonia, Pohnpei	2 rooms	15 years, fair	none, needs renovation
Palau						
Hawaii	Arthropod	Yes	Honolulu, HI	800 sq ft	60 years	4
	Pathogen	Yes	Honolulu, HI	120 sq ft	17 years	1
	Arthropod	Yes	Volcano, HI	1200 sq ft	25 years	4
Niue	None,					
Tonga	Laboratory	Yes	Vaini Research Station	small, one agent at a time	10 yrs – needs upgrade	n/a
Vanuatu	Post Entry Quarantine facility	Not certified but built in accordance to the SPC and FAO guidelines and requirements	Port-Vila Vanuatu	6 x 9 building	6 years but needs some repair	none

Samoa	Laboratory	yes	Nuu Coop Station	20 sq. ft	Old & hot	5
	Post Entry Station	yes	Nuu Coop Station	20 sq. ft	Old & hot	
Fiji	Laboratory	Yes	KRS	3 x 10 m	Old	1
	Pest Quarantine Laboratory	No	KRS	4 x 8 m	Ugrading needed	1
PNG	1.Post Entry Quarantine	PNG NAQIA	NARI Keravat	small	Renovated 1yr ago	Rust fungus- *Puccinia spegazzinii*
	(Imported biocontrol agents)			36sqm	Excellent condition	
				Triple door entry		
	2. Internal Quarantine	PNG NAQIA	NARI Keravat	small	Renovated 3yrs ago	None
	(movement of plants in country)			3 rooms at 36sqm	(Cocoa pod borer Quarantine)	
					Excellent condition	
	3. Laboratory	Ramu Estates	Ramu	small	20yrs	none-all in the field

PACIFIC ISLAND BIOCONTROL PROGRAMS – 5 year snapshot						
Country	Agency/Org	Average annual budget	# agents released	# agents in process	# countries supported	Funding sources
Guam	University of Guam	small projects of $50K per year or less	8	0	4	
Cook Islands	Ministry of Agriculture	none	1 new within the country	1-relying on field collections		SPC
			4 spread to outer islands			
French Polynesia	Service du développement rural	1,500,000 XPF	3	3		French Polynesia government
New Caledonia	IAC	400 Millions XPF	2	0		NC Government
	DDR – Province Sud	100 Millions XPF	0	2		NC Province Sud
CNMI	UOG, Guam	$9,000.00				
American Samoa	ASCC	need info	1	0		USDA
FSM	T+STAR Proj , USDA	none	2			USDA, T-STAR, USFS
Palau						
Hawaii	HDOA	$1.2 mil (whole program including staff, infra structure, operating costs not just classical biocontrol program)	1	4	State of Hawaii, Tri Isle	
	FS	$250,000	0	10	FS, State of Hawaii, National Park Service	
	ARS			1	USDA	
	UH Manoa				USDA	
Nuie	Biosecurity			2		SPC
Tonga	CSIRO		Eretmoceries hayati	1 in 2006	ACIAR, DPI	
Samoa	MAF		None	5+		SPC, ACIAR, NZ, MAF, Local budget
Fiji	ACIAR			2 – Mikania – Graffea;		
				Sida acuta, rhombifolia		
PNG	Current ACIAR funded project		Gall fly – *Cecidochares*	*Puccinia spegazzinii*		
			Connexa			
			Calycomyza eupatorivora			

PACIFIC IS. BIOCONTROL PRACTICIONERS

Country	Name	Title	Affiliation	email	current target weeds	current target pests	current agents in Quarantine
Guam	Ross Miller	Professor	University of Guam	rmiller@uguam.uog.edu		aphids, asian cycad scale	
	Aubrey Moore	Assistant Professor	University of Guam	amoore@uguam.uog.edu		coconut rhinocerus beetle, Asian cycad scale	
	G.V.P. Reddy	Assistant Professor	University of Guam	reddy@uguam.uog.edu		papaya mealybug, chromolaena, Coccinia grandis	
Cook Islands	Poeschko Maja	Entomologist PhD	Ministry of Agriculture	research@oyster.net.ck	none	Aspidiotus destructor, Unaspis citri, Aleurodicus dispersus, Agonoxena argaula	
French Polynesia	Rudolph Putoa	Entomologist	Service du développement rural	rudolph.putoa@rural.gov.pf		Bactrocera fruit flies, Brontispa longissima	
	Julie Grandgirad	Entomologist	Service du développement rural	julie.grandgirard@rural.gov.pf		GWSS, vegetables pests	
	Jean-Yves MEYER	Ecology researcher	Délégation à la Recherche	jean-yves.meyer@recherche.gov.pf	Miconia calvescens		
New Caledonia	JOURDAN Hervé	PhD	IRD	herve.jourdan@ird.fr	Acanthocereus tetragonus		
	GATIMEL Bruno	MSc	DDR	bruno.gatimel@province-sud.nc		Bemisia tabaci, Trialeurodes vaporariorum	
	MILLE Christian	PhD student	IAC	mille@iac.nc	Salvinia molesta, Eichhornia crassipes,	Bactrocera spp., Helicoverpa spp.,	
CNMI	Dr Dilip Nandwani	Pathologist	NMC-CREES	dilipn@nmcnet@edu	Chromolaena		released
	Arnold Route	Agri Ext Agent	NMC-CREES	arnoldr@nmcnet.edu	Mimosa diplotricha		released
	Dr GVP Reddy	Entomologist	CALS-UOG	reddy@uguam.uog.edu	Coccina grandis		released
	Dr R Miller		CALS-UOG	rmller@uguam.uog.edu		Aphid	
American Samoa	Mark Schmaedick	Entomologist	ASCC	m.schmaedick@amsamoa.edu	none	Icerya seychellarium; Quadristichus erythrinae	
New Zealand	Peter Maddison	Driector, Field Studies	Landcare Res. NZ	maddisonp@clearnet.nz	documenting taxonomy		
FSM	none						
Palau	Joel Miles	Nat. Inv. Species Coord	Bureau of Agriculture	nisc@palaunet.com	none	Cycad scale	
	Pasqual Ongos	?	Bureau of Agriculture	?	none	Cycad scale	
	Joseph Tiobech	Inv. Plt. Erad. Coord.	Bureau of Agriculture	palauforestry@palaunet.com	Clidemia hirta		
	?	?	Palau Comm. Coll.		Chromolaena odorata, Mimosa diplotricha	taro planthopper, red spider mite	

PACIFIC IS. BIOCONTROL PRACTICIONERS							
Country	Name	Title	Affiliation	email	current target weeds	current target pests	current agents in Quarantine
Hawaii	Darcy Oishi	Biological Control Section Chief	HDOA	darcy.e.oishi@hawaii.gov	fireweed, fountain grass, ivy gourd, miconia, clidemia,	EGW	
	Juliana Yalemar	Insectary Entomologist	HDOA	juliana.a.yalemar@hawaii.gov		EGW	
	Mohsen Ramadan	Exploratory Entomologist	HDOA	mohsen.r.ramadan@hawaii.gov	fireweed, fountain grass, ivy gourd, miconia, clidemia,	EGW	
	Mann Ko	Plant Pathologist	HDOA	mann.ko@hawaii.gov	clidemia, miconia,		
	Rene Bautista	Insectary Supervisor	HDOA	renato.bautista@hawaii.gov	fireweed, fountain grass, ivy gourd, miconia, clidemia,	EGW	
	Tracy Johnson	Research Entomologist	FS	tracyjohnson@fs.fed.us	miconia, strawberry guava, Tibouchina herbacea, Rubus ellipticus, Bocconia frutescens		
	Erin Raboin	Biological Technician	FS	eraboin@fs.fed.us	miconia, strawberry guava, Tibouchina herbacea		
	Peter Follett	Research Entomologist	ARS			white peach scale	Encarsia diaspidicola
	Roger Vargas	Research Entomologist	ARS			Bactrocera spp.	
	Russell Messing	Professor	UH Manoa			aphids	
	Mark Wright	Professor	UH Manoa				
Niue	New Aue	Quarantine officer		biosecurity1_niue@mail.gov.nu	wedelia, chain of love, mimosa		
Tonga	Pila Kami	Principal Ag Officer	MAFF	maf-ento@kalianet.to			
Samoa	Aleni Uelese	Research Officer					
	Juvita Toue	Research Officer					
	Billy Enosa	Research Officer		fbenosa@lesamoa.net			
	Piue Paenoa	Quarantine officer		leppanoa@hotmail.com			
Fiji	Bal ----	Senior Research officer	MAFF	al.swamy@ ……	Mikania, Rhino beetloe		
	Andrea Deeds		MAFF				
	Jonetan	Technician	ACIAR	……	Mikania		

PACIFIC IS. BIOCONTROL PRACTICIONERS							
Country	Name	Title	Affiliation	email	current target weeds	current target pests	current agents in Quarantine
Papua New Guine	Annastasia Kawi	Entomologist	PNG NARI	anna.kawi@nari.org.pg	Mikania micrantha		rust fungus-Puccinica spegazzinii
	Kiteni Kurika	Reseach Associate	PNG NARI	kiteni.kurika@nari.org.pg	Mikania micrantha		rust fungus-Puccinica spegazzinii
	Dr. John Moxon	Entomologist	NARI	john.moxon@nari.org.pg			
	Ms. Amanda Marauai	Entomologist	NARI	amanda.marauai@nari.org.pg			
	Dr. Mark Ero	Entomologist	NARI	mark.ero@nari.org.pg			
	David Tenakanai	Entomologist	NAQIA	dtenakanai@naqia.gov.ph			
	Tony Gunua	Plant Pathologist	NAQIA	tgunua@naqia.gov.pg			
	Margorie Kame	Entomologist	NAQIA	mkame@naqia.gov.pg			
	Dr. Charles Dewhurst	Entomologist	PNGOPRA	charles.dewhurst@pngopra.org.pg			
	Mr. Pere Kolcoh	Nematologist	NAQIA				
	David Putulan	Entomologist	PNGOPRA	david.putulan@pngopra.org.pg			
	Philo Aisa	Scientist	PNGCCI	philo.aisa@yahoo.com			
	Sebastian Endupa	Scientist	PNGCCI	sebastian.endupa@yahoo.com			
	Lelea Tom	Scientist	NAQIA	itom@naqia.gov.pg			
	Dr. Carmel Pilloti	Plant Pathologist	OPRA				
	Mark Kenny	Plant Pathologist	PNGCIC				
	Nelson Simbliken	Entomologist	PNGCIC				
	David Putulan	Entomologist	PNGOPRA				
	Otto Ningere	Entomologist	PNGCIC				
	Kaile Korowi	Entomologist	Ramm Argi Industries	kkorowi@rai.com.pg			
	Dr. Lastus Kuniata	Entomologist	Ramm Argi Industries	lkuniata@rai.com.pg			
	Mr. Macqueen Mairo	Entomologist	University of Technology	?			
	Mr. Inga Boteng	Weed Biocontrol	PNGCRI				
	Dr. Saison ????	Entomologist	CCI				
	Dr. Solomon Balagawi	Entomologist Fruit flies	QUT				
	Mr. Roy Masamdu	Entomologist	SPC				
	Mrs. Josephine Saul Maura	Plant Pathologist	PNGCCI	josephine.saul@yahoo.com			
	Warea Orapa	Plant Health Coordinator		worapa@spc.org			

INFRASTRUCTURE: BIOCONTROL FACILITIES SUPPORTING PACIFIC ISLAND NEEDS						
Country/Org	Facility type	Certified?	Location	Size/capacity	Age/ condition	# agents in facility
UOG	2 room quarantine facility	yes	UOG Campus, Mangilao Guam	two 10ft X 10ft rooms	Old house from 1970s, refurbished about 2000	
CABI	Quarantine	Yes, UK DEFRA approved	Egham, Surrey UK	4 glasshouse chambers + 4 CT rooms (each approx. 8 X 4m)	New (2008/9)	*Puccina lantanae – (Lantana camara) Puccinia spegazzinii – (Mikania micrantha)*
Landcare NZ	Arthropod containment	Yes	Lincoln, NZ	160 m2	New 2010 – state of the art	lots
CSIRO	Quarantine	yes	Brisbane, Au	-	Old but good; new in 2011	-
QPIF	Quarantine	Yes	Brisbane	>300 m2	30 yrs	4
	Quarantine	Yes	Brisbane	>300 m2	30 yrs	4
SPC	PCR and molecular lab	yes	Fiji	1 bedroom size	2	
	Weed lab	yes	Fiji	1 bedroom size	5	1
	Plant pathology lab	yes	Fiji	1 bedroom size	20	
	Biocontrol laboratory	yes	Fiji	1 bedroom size	30	10
Fiji – Koronivia	Plant pathology lab	yes	Fiji	-	Over 50 years	-
	Weed lab	yes	Fiji	-	Over 50 years	-
	Fruit flies laboratory	yes	Fiji	-	Over 50 years	-
	Biocontrol	yes	Fiji	-	Over 50 years	-

BIOCONTROL PROGRAMS SUPPORTING PACIFIC ISLAND NEEDS – Snapshot of last 5 years				
Agency/Org	Average annual budget	# agents released	# agents in process	Countries supported
University of Guam	Small projects of $50K per year or less	8	0	4
SPC, (Fiji), NARI (PNG)	£27K (mainly ACIAR though Department of Primary Industries and Fisheries + top-up from SPC)	Puccinia spegazzinii		PNG, Fiji
CRC	$200k Australian	none (quarantine)	1	PNG
CRC	?	none (monitoring)	1 poss	PNG
Landcare	NZ 2-3 million			
ACIAR		none at present but could		
QPIF	$1 mill	4	6	Qld Govt, Commonwealth, Landcare, MLA
QDPI&F	$1 mill	4	5	PNG, Fiji

BIOCONTROL STAFFING: PRACTITIONERS WITH PROJECTS IN THE PACIFIC						
Name	Title	Affiliation	email	current target weeds	current target pests	current agents in Quarantine
Ross Miller	Professor	University of Guam	rmiller@uguam.uog.edu	none	aphids, asian cycad scale	none
Aubrey Moore	Assistant Professor	University of Guam	amoore@uguam.uog.edu	none	asian cycad scale, coconut rhinocerus beetle	none
G.V.P. Reddy	Assistant Professor	University of Guam	reddy@uguam.uog.edu	several	papaya mealybug, *Coccinia grandis, Chromolaena odorata*	
Djami Djeddour	Mrs	CABI	d.djeddour@cabi.org	Wild gingers		
Marion Seier	Dr	CABI	m.seier@cabi.org	Jatropha, *Mimosa pigra*		
Harry Evans	Dr	CABI fellow	h.evans@cabi.org	everything		
Rob Reeder	Dr	CABI	r.reeder@cabi.org	*Rottboellia cochinsinensis*		
Dick Shaw	Dr	CABI	r.shaw@cabi.org		coffee green scale	
Sean Murphy	Dr	CABI	s.murphy@cabi.org		coffee green scale	
Carol Ellison	Dr	CABI	c.ellison@cabi.org	*Mikania micrantha* (project completed advisory role only now) Lantana		*Puccinia spegazzinii* (released)
Peter Baker	Dr	CABI	p.baker@cabi.org		coffee berry borer	
Lynley Hayes	Tech Transfer/ project management	Landcare Research	HayesL@landcareresearch.co.nz	Numerous projects and those of interest to Pacific incl: lantana, wild ginger, banana passionfruit, woolly nightshade		
Hugh Gourlay	Entomologist and Quarantine	Landcare Research	GourlayH@landcareresearch.co.nz	LCR Weed biocontrol team		
Lindsay Smith	Entomologist	Landcare Research	SmithL@landcareresearch.co.nz	LCR Weed biocontrol team		
Helen Parish	Insect rearing	Landcare Research	ParishH@landcareresearch.co.nz	LCR Weed biocontrol team		
Simon Fowler	Entomologist	Landcare Research	FowlerS@landcareresearch.co.nz	LCR Weed biocontrol team		
Quentin Paynter	Entomologist	Landcare Research	PaynterQ@landcareresearch.co.nz	LCR Weed biocontrol team		
Stan Bellgard	Plant pathologist	Landcare Research	BellgardS@landcareresearch.co.nz	LCR Weed biocontrol team		
Sarah Dodd	Plant pathologist	Landcare Research	DoddS@landcareresearch.co.nz	LCR Weed biocontrol team		

BIOCONTROL STAFFING: PRACTITIONERS WITH PROJECTS IN THE PACIFIC						
Name	Title	Affiliation	email	current target weeds	current target pests	current agents in Quarantine
Daniel Than	Plant pathologist	Landcare Research	ThanD@ landcareresearch.co.nz	LCR Weed biocontrol team		
Chris Winks	Entomologist	Landcare Research	WinksC@ landcareresearch.co.nz	LCR Weed biocontrol team		
Paul Peterson	Entomologist	Landcare Research	PetersonP@ landcareresearch.co.nz	LCR Weed biocontrol team		
Ronny Groenteman	Entomologist	Landcare Research	GroentemanR@ landcareresearch.co.nz	LCR Weed biocontrol team		
Mic Julien		CSIRO				
Bill Palmer	Dr	QDEEDI	Bill.Palmer@deedi.qld.gov.au	mother-of-millions, madeira vine, prickly acacia, bellyache bush		3
Dhileepan	Dr	QDEEDI	K.Dhileepan@deedi.qld.gov.au	cats claw creeper, prickly acacia, bellyache bush		0
Michael Day	Mr	QDEEDI	Michael.Day@deedi.qld.gov.au	lantana, chromolaena, mikania		0
Di Taylor	Ms	QDEEDI		bellyache bush, cats claw creeper		0
Catherine Lockett	Ms	QDEEDI		prickly acacia, bellyache bush		0

Appendix 6

List of priority arthropod pests

Note the first table shows the importance of arthropod pests to PICTs (red = priority pests; blue – moderately important; brown – present but not of concern) and the second table shows if biocontrol agents are available.

	PICTs	AS	CI	FSM	Fiji	FP	Guam	Kirib.	Nauru	NC
Rhinoceros beetle	*Oryctes rhionoceros*	x			x		x			
Coconut scale	*Aspidiotus destructor*		x		x					
Coconut hispa	*Bronstispa spp.*			x		x	x			x
Coconut leaf miner	*Promecotheca spp.*									
Coconut stick insect	*Graffea crounii*				x					
Coconut flat moth	*Agonoxena argaula*				x					
Taro beetle	*Papuana spp.*				x			x		x
Taro horn worm	*Hippotion celerio*									
Taro plant hopper	*Tarphagus proserpina*			x			x			
Fruit piercing moth	*Eudocima phallonia*	x		x	x		x			x
Spiraling whitefly	*Aleurodicus dispersus*	x	x	x	x	x	x	x	x	x
Sweet potato whitefly	*Bemisia tabaci*		x		x	x	x			x
Silverleaf whitefly	*Bemissia argentifolia*		x		?	x	x			x
Cabbage white butterfly	*Pieris rapae*									
Diamondback moth	*Plutella xyllostella*		x		x	x	x	x	x	x
Banana scab moth	*Naecolia octasema*				√					
Rose beetle	*Adoretus versutus/ A. sinicus*		x		x					x
Pumpkin beetle	*Aulacophora spp.*				x		x			x
White peach scale	*Pseudalacaspis pesntapona*				x					
Squash bug	*Mictis profana*				x					x
Cycad scale	*Aulacaspis yasumatsui*						x			
Glassy winged sharpshooter	*Homolodisca vitripennis*									
Green peach aphid	*Myzus persicae*									

	Niue	NMI	PNG	Palau	Pitcn.	RMI	Samoa	SI	Tokel.	Tonga	Tuvalu	Vanu.	W&F
			x	x			x		x	x			x
											x		
							x				x		
								x				x	
								x		x			
			x									x	
			x					x			x		
	x		x	x			x	x		x		x	
	x	x	x	x		x	x	x	x	x	x	x	x
	x		x	x			x	x		x		x	x
										x			
	x	x	x	x			x	x		x		x	x
							x						
							x			x		x	
		x		x								x	
							x	x					
			x										
		x		x									

	PICTs	AS	CI	FSM	Fiji	FP	Guam	Kirib.	Nauru	NC
Cabbage aphid	*Brevicoryne brassicae*				x					
Aphis gossypii	*Aphis gossypii*				x					
Cucumber caterpillar	*Diaphania sp*									x
Centre grub	*Hellula undalis*									
Large cabbage moth	*Crocidolomia pavonana*									
Erythrina gall wasp	*Quadrastichus erythrinae*	x			x					
Mealy bugs	*several*		x			x	x		x	x
Little fire ant	*Wasmania auropuntata*					x				x
Bean pod borer	*Maruca vitrata*				x					x
Banana weevil	*Cosmopolites sordidus*				x		x			x
Banana skipper	*Erionota thrax*									
Bele leaf miner	*Acrocercospora sp.*				x					
Spodoptera litura	*Spodoptera litura*	x	x	x	x	x	x			x
Melon thrip	*Thrips palmae*				x	x	x			x
Rice brown planthooper	*Nilaparvat lugens*				x					
Bele short-tip borer	*Earias fabiae*				x		x			
Sweet potato weevil	*Cylas formicarius*				x		x			x
Breadfruit mealybug	*Icerya aegiptica*				x			x		
Oriental scale	*Aonidiela orientalis*							x		
Spider mite	*Tetranichus lambi*	x	x	x	x	x	x	x	x	x
Nisotra beetle	*Nisotra basellae*									
Brown soft scale	*Coccus hesperidum*				x	x	x			x
Ladybird beetle	*Epilachna vigintiopunctata*	x	x	x	x	x	x			x
Papaya mealybug	*Paracoccus marginatus*						x			
Greasy cutworm	*Agrotis ipsilon*				x	x	x			x
California Red scale	*Aonidiela aurantii*					x	x			
Green tortoise beetle	*Cassida compuncta*				x		x			
Crazy ant	Anoplolepis graciles				x					

	Niue	NMI	PNG	Palau	Pitcn.	RMI	Samoa	SI	Tokel.	Tonga	Tuvalu	Vanu.	W&F
							x						
							x			x			
			x				x			x			
			x	x									
								x				x	
			x				x			x			
		x	x										
			x										
								x				x	
		x	x	x			x	x		x		x	x
			x										
			x										
							x					x	
			x				x			x		x	
	x	x	x	x	x	x	x	x	x	x	x	x	x
			x					x					
			x	x			x	x	x			x	x
	x	x	x	x			x	x		x		x	x
				x									
			x				x			x		x	
			x										
				x				x					
							x						x

	PICTs	AS	CI	FSM	Fiji	FP	Guam	Kirib.	Nauru	NC
Rice leafroller	*Marasmia exigua*				x					
Fruit flies	Bactrocera spp.	x	x	x	x	x	x	x	x	x
Coffee green scale										
Corm ear worm	*Helicoverpa armigera*	x	x	x	x	x	x			x
Pink wax scaled	*Ceroplastes*		x		x	x	x			x
Red banded caterpillar			x							
Brown citrus aphid							x			x
Cowpea aphid					x	x	x			x
Citrus rind bore										
Fire ant	*Solenopsis geminata*									x
Termites	*Neotermes spp.*				x					
Eriophid mites							x			
Banana aphid	*Pentalonia nigronervosa*				x		x			
Broad mite			x		x	x	x			x
Citrus blossom beetle	*Protaea fusca*				x	x	x			x
Mango leaf hopper										
Western flower thrip	*Frankiniella*					x	x			x
Greenhouse whitefly	*Aleutrachelus trachoides*			x			x			x
Common ant	*Pheidole megacephala*				x					x
Rice bug	*Leptocorisa spp.*					x				x
Glasshouse white fly	*Trialeurodes vaporariorum*									x
Potato tuber moth	*Phthorimaea operculella*				x					x
Seme looper	*Plusia chalcites*				x					x
Snow scale	*Pinnaspis strachani*	x			x	x	x			x

	Niue	NMI	PNG	Palau	Pitcn.	RMI	Samoa	SI	Tokel.	Tonga	Tuvalu	Vanu.	W&F
			x										
	x	x	x	x	x	x	x	x	x	x	x	x	x
		x	x	x			x	x		x		x	x
			x				x						
			x										
				x									
				x									
										x			
				x			x			x			
										x			
		x		x									
			x							x			
			x				x						
			x				x	x		x		x	x

		BCA in PICTs	Known outside region	Utilize current research	Selecting	No information
Rhinoceros beetle	*Oryctes rhionoceros*	x	x			
Coconut scale	*Aspidiotus destructor*	x				
Coconut hispa	*Bronstispa spp.*	x				
Coconut leaf miner	*Promecotheca spp.*	x				
Coconut stick insect	*Graffea crounii*	x				
Coconut flat moth	*Agonoxena argaula*	x				
Taro beetle	*Papuana spp.*	x	x			x
Taro horn worm	*Hippotion celerio*	x				
Taro plant hopper	*Tarphagus proserpina*	x				
Fruit piercing moth	*Eudocima phallonia*	x			x	
Spiraling whitefly	*Aleurodicus dispersus*	x				
Sweet potato whitefly	*Bemisia tabaci*		x			
Silverleaf whitefly	*Bemissia argentifolia*		x			
Cabbage white butterfly	*Pieris rapae*	x				
Diamondback moth	*Plutella xyllostella*	x				
Banana scab moth	*Naecolia octasema*	x				
Rose beetle	*Adoretus versutus/ A. sinicus*	x			x	
Pumpkin beetle	*Aulacophora spp.*					x
White peach scale	*Pseudalacaspis pesntapona*	x				
Squash bug	*Mictis profana*	x				
Cycad scale	*Aulacaspis yasumatsui*	x				
Glassy winged sharpshooter	*Homolodisca vitripennis*	x				
Green peach aphid	*Myzus persicae*	x				
Cabbage aphid	*Brevicoryne brassicae*	x				

		BCA in PICTs	Known outside region	Utilize current research	Selecting	No information
Aphis gossypii	*Aphis gossypii*	x				
Cucumber caterpillar	*Diaphania sp*					x
Centre grub	*Hellula undalis*					x
Large cabbage moth	*Crocidolomia pavonana*	x			x	x
Erythrina gall wasp	*Quadrastichus erythrinae*		x	x		
Mealy bugs	several	x	x		x	
Little fire ant	*Wasmania auropuntata*				x	x
Bean pod borer	*Maruca vitrata*	x			x	x
Banana weevil	*Cosmopolites sordidus*	x			x	x
Banana skipper	*Erionota thrax*	x				
Bele leaf miner	*Acrocercospora sp.*	x				
Spodoptera litura	*Spodoptera litura*	x				
Melon thrip	*Thrips palmae*				x	x
Rice brown planthooper	*Nilaparvat lugens*	x				
Bele short-tip borer	*Earias fabiae*	x				
Sweet potato weevil	*Cylas formicarius*					x
Breadfruit mealybug	*Icerya aegiptica*	x				
Oriental scale	*Aonidiela orientalis*	x				
Spider mite	*Tetranichus lambi*	x				
Nisotra beetle	*Nisotra basellae*					x
Brown soft scale	*Coccus hesperidum*	x				
Ladybird beetle	*Epilachna vigintiopunctata*				x	x
Papaya mealybug	*Paracoccus marginatus*	x				
Greasy cutworm	*Agrotis ipsilon*	x				x
California Red scale	*Aonidiela aurantii*	x	x			
Green tortoise beetle	*Cassida compuncta*					x

		BCA in PICTs	Known outside region	Utilize current research	Selecting	No information
Crazy ant	*Anoplolepis graciles*		x			x
Rice leafroller	*Marasmia exigua*	x				
Fruit flies	*Bactrocera spp.*	x	x		x	x
Coffee green scale						x
Corm ear worm	*Helicoverpa armigera*	x				
Pink wax scaled	*Ceroplastes*	x				
Red banded caterpillar						x
Brown citrus aphid		x				
Cowpea aphid						x
Citrus rind bore						x
Fire ant	*Solenopsis geminata*					x
Termites	*Neotermes spp.*	x				x
Eriophid mites						x
Banana aphid	*Pentalonia nigronervosa*	x				
Broad mite		x				
Citrus blossom beetle	*Protaea fusca*					x
Mango leaf hopper						x
Western flower thrip	*Frankiniella*				x	x
Greenhouse whitefly	*Aleutrachelus trachoides*					
Common ant	*Pheidole megacephala*					x
Rice bug	*Leptocorisa spp.*					x
Glass house whitle fly	*Trialeurodes vaporariorum*	x	x			
Potato tuber moth	*Phthorimaea operculella*	x				
Seme looper	*Plusia chalcites*	x				
Snow scale	*Pinnaspis strachani*	x				

Appendix 7

Minutes of Steering Group Committee's first meeting

The following people agreed or were nominated to form the initial committee:

First Names	Surnames	Email	Organisation	Country/Region	
Mark	Bonin	markb@sprep.org	Pacific Invasives Learning Network (PILN)	Samoa/Regional	
Tony	George	naqs@dg.com.pg	NAQIA	PNG	
Billy	Enosa	fbenosa@lesamoa.net	MAFF	Samoa	
Tracy	Johnson	tracy.johnson@fs.fed.us	USDA-Forest Service	Hawaii	
Mic	Julien	mic.julien@csiro.au	CSIRO	Australia	
Wilco	Liebregts	ecoconsult@is.com	EcoConsult	Fiji	
Christian	Mille	mille@iac.nc	IAC	New Caledonia	
Darcy	Oishi	darcy.oishi@hawaii.gov	HDOA	Hawaii	
Warea	Orapa	WareaO@spc.int; warea.orapa@gmail.com	SPC	Fiji/Regional	
Quentin	Paynter	paynterq@landcareresearch.co.nz	Landcare Research	NZ	
Richard	Shaw	r.shaw@cabi.org	CABI	UK	
Alan	Tye	alant@sprep.org	SPREP	Samoa/Regional	
Konrad	Englberger	konrad.englberger@gmail.com	Pohnpei Conservation Society	Federated States of Micronesia	
Souad	Boudjelas	s.boudjelas@auckland.ac.nz	Pacific Invasives Initiative (PII)	New Zealand/ Regional	
Alternates					
Carol	Ellison	c.ellison@cabi.org	CABI	UK	for Dick
Lynley	Hayes	hayesl@landcareresearch.co.nz	Landcare Research	NZ	for Quentin
Sarah	Dodd	dodds@landcareresearch.co.nz	Landcare Research	NZ	for Quentin
Roy	Masamdu	roym@spc.int	SPC	Fiji/Regional	for Warea
Anne Marie	LaRosa	alarosa@fs.fed.us	USDA-Forest Service	Hawaii – Regional	For Tracy

It was decided to have an inaugural meeting at 12.30 on Thursday 18 November 2009.

Minutes of the inaugural meeting of the steering group committee for biological control in the Pacific

Present: Quentin, Dick, Konrad (for Fred), Wilco, Darcy, Mark, Mic, Christian, Tracy, Billy, Bill (for Souad), Roy (for Tony), Sarah and Warea.

Business

Chairman: Warea Orapa was elected Interim Chair.

Communications

ACTION – Warea to develop an emailing list and send it to everyone as soon as possible.

Duties of the committee

ACTION – All members to send ideas for the Terms of Reference (using existing ToR from other committees), strategy (mission) and goals to Darcy.

ACTION – Darcy to draft ToR, strategy, goals and timeframes and to circulate to all before Xmas for comment.

Recognition

This is an advisory committee but we need to work towards gaining recognition and trust so that we can influence decisions and help set agendas.

ACTION – Warea to have an agenda item included in the next Minsters of Agric and Forestry meeting due in 2010 in Tonga.

Aim to present the ToR etc and an initial document on the prioritisation of biological control projects in the Pacific to that meeting to obtain support and recognition.

Directions for the committee

Once we have the report of the workshop (due end November 09) that contains recommendations for the committee we will begin a discussion of directions, targets and timeframes. These will likely include, in relation to biological control in the Pacific, the following:

- Communications
- Technical expertise
- Funding
- Development of viable projects

Sub-committees

There may be need for various sub committees as follows:

- Finance
- Administration
- Regional
- Communications and liaison
- Executive

Committee name

A number of ideas were suggested:

- PBC3 (Pacific Biological Control Coordinating Committee) (Mic)
- Call the whole network: Pacific Biological Control Network (PBCN). The committee could then be either a PBCN Committee or PBCN Coordinating Group (Warea).

A name was not decided.

NEXT MEETING: To be decided once we have developed the Terms of Reference, strategy, and worked on the recommendations from the workshop.

Appendix 8:

Potential funding sources

Funding	Amount	Timeframe	Countries eligible	Comments
ACIAR: Australian Centre for International Agricultural Research	800–1.5M	2–5 yrs	Most Polynesia (e.g. PNG, Vanuatu, Samoa,Tonga) but excluding NZ and French territories	Strong business case, involving an Australian research agency and one or more developing countries, open every month, plan 2 yrs in advance
USDA-TSTAR: United Stated Department of Agriculture -Tropical and Sub-tropical Agriculture research	2 M max	2 yrs max	Micronesia + US territories	Agricultural focus
USDA-APHIS: United Stated Department of Agriculture – Animal and Plant health Inspection Service	30K p.a.		US affiliates	quarantine focus
USDA-NIFA: United Stated Department of Agriculture – National Institute of Food and Agriculture	200 k p.a.		US affiliates	Ag focus
USDA-FS: United Stated Department of Agriculture –Forest Service	300 k p.a.		US affiliates	Forestry focus, Multi country
USDA-SARE: United Stated Department of Agriculture – Sustainable Agriculture and Research Education	200k p.a. (60 K for single state)		US affiliates	Educational in 3 area
USDA-NRCS: United Stated Department of Agriculture – national resources Conservation Service			US affiliates	National and regional
French Pacific Fund	15K Euro			Need to match money (e.g. SPC) Must have regional link
Dumont foundation/ FRST (NZ/French bilateral funds) fund)			NZ/French focus. New Caledonia not eligible.	Science exchange programme

Funding	Amount	Timeframe	Countries eligible	Comments
EU: European Union	Various funds			Training, capacity building in developing countries, mutual benefit, infrastructure e.g. building quarantine facilities.
CEPF: Critical Ecosystem Partnership Fund	200k or 25k funds		CEPF hot spot countries	
GTZ: Deutsche Gesellschaft für Technische Zusammenarbeit			Worldwide	German technical fund -Mitigate Climate change
AUSAID: Australian aid fund	800K p.a.			Mainly training
NZAID: New Zealand aid fund				Participation at workshops, and university study.
IFAD: International Fund for Agricultural development	12-20M			200K USD per project. Focus on sustainable development
FEAST: Forum for European Australian Science and technology cooperation				To increase collaboration between European and Australian researchers
FRENZ: Facilitating Research co-operation between Europe and New Zealand				To increase collaboration between European and NZ researchers
FAO: Food and Agriculture Organisation of the United Nations	400M p.a. total budget			
GEF: Global Environment Fund	400K annual budget		10 countries eligible	Country driven projects
UNDP: United nations Development programme				
Taiwanese/Pacific fund				
World bank			Worldwide	Country loans for development
CFC: Common Fund for Commodities				For selective commodities only

Appendix 9:
Agreed actions

List of actions for individuals

Anne Marie

- Keep capacity survey updated
- To instigate better coordination of US Federal agencies in Micronesia
- Coordinate Regional/territorial Foresters in Micronesia
- Talk to HEAR website about setting up Pacific biocontrol list server

Quentin Paynter

- Remove weed importance from the Landcare Research model and run Pacific Island weeds through to rank them

Konrad, Mic, Warea, Mark B, Tony George, Anne Marie, and Alan Tye:

- Group to check data going into Quentin's model

Anne Marie, Warea, Mark B and Konrad:

- Source funding for Quentin's work.

Mic Julien and Warea Orapa:

- Collate feedback from everyone after the workshop and finalise the weed list

Sada:

- Collate feedback from everyone after the workshop and finalise the Arthropod list

Darcy:

- Look into using Skype for regular quarterly conferencing in Polynesian countries

Bal Swamy, Bruno Gatimel, Tony George Gunua, Sylverio Bule, Helen /John Fasi:

- To act as contact person in their country for disseminating information in Melansia

All 10 biocontrol practitioners in Micronesia:

- Set up Micronesian biocontrol steering group

Aubrey:

- To set up Internet-based working group for all regions of Micronesia

Individuals with tasks listed in strategic plan projects details of actions listed in text in Strategic Plan section:

- Mic, Reddy, Mark B – Optimising biocontrol in the Pacific
- Warea, Wilco – New Spathodea project
- Lynley, Bill, Mark B – Merremia DNA study to determine origin and native range
- Muni – IPM of vegetables
- Christian – Update arthropod pest list for publication
- Warea – Update Waterhouse biocontrol guidelines
- Darcy, Anne Marie, Greg Sherley, Alan Tye, Juliana – Eurythrina gall wasp
- Ross, Tracy, Darcy, Dick Shaw – Ants/hemiptera
- Muni – Fruit flies and fruit piercing moth
- Lynley, Dick – Hedychium garderianum (wild ginger)
- Tracy – Biocontrol of melastomes

List of actions for the Steering Committee to consider:

Overcoming barriers to biocontrol

- Set up an independent advisory group (~6 people) to review biocontrol agent release applications for all Pacific Islands, to provide peer review advice. Must be recognised, trusted individuals and there would need to be some consistency in the group membership. Must meet regularly to review – (travel vs telecommunication?). Should meet regularly with Ministers and Heads of Agriculture and Forestry (could attend 2-yearly meetings).Members should include range of specialists (e.g. entomologist, pathologist, botanist, quarantine, communications, economics, systematists)
- Raise public awareness
- Educate local communities with emphasis on good versus bad
- Identify champions in local communities
- Local radio programmes, TV documentaries, videos, news items
- Target groups, e.g. youth, school curriculum, women, church groups, field days
- Create outreach materials – posters, videos, audiovisual materials, buttons, caps
- Access to policy makers
- Have regular presence at regional meetings to keep biocontrol on the radar with policy makers
- Identify key meetings to attend (make a list, e.g. CRGA, PPPO, SPC, SPREP, MoAFs, farmer organisations)
- Convince policymakers with business cases

- Engage social science to capture impact data at village level – examples of adding real value to lives
- Develop a common biocontrol message that can be delivered at any meeting – preferably using Pacific examples with cost-benefit data available (e.g. Anne Marie strawberry guava)
- Co-ordinating committee need to choose a name carefully to get best overall reception
- Regulatory framework
- Involve regulatory officials in projects early on – cultivate contacts
- Provide independent expert advice to regulator – (e.g. advisory group)
- Influence regulators (e.g. Animal and Plant Health Inspection Service (APHIS), US Fish and Wildlife Service (USFWS), RISC and other regional policy groups)
- Work with National Science Foundation (NSF), NIFA, GISAC programme leaders
- Work with local Environmental Protection Agency (EPA) officials
- Participate in legislative actions where appropriate

Improving biocontrol communication

- Investigate website/list server
- Investigate HEAR website –about setting up list servers
- Liaise with PILN

Appendix 10

Results of workshop evaluation survey

Of the 37 evaluation forms received, 86% gave the workshop an overall rating of 8 or higher out of a possible 10 where 0 = bad and 10 = outstanding. Ten scored the workshop as outstanding (10) and only one gave the lowest score of 6.

When asked if the workshop had achieved its goal, all but two participants thought 'yes'. Of the two remaining, both selected the 'unsure' option.

When asked 'why' or 'why not' to the above question, the answers were:

- Well organised and facilitated, with clear agenda
- Identified needs, came up with clear recommendations for practical collaborative actions and delegated responsibilities
- Set up steering committee with clear tasks to move ideas forward
- Good sharing of experiences and ideas
- Achieved goals and outcomes listed on Day One
- Enthusiasm of participants and willingness to collaborate
- Bought biocontrol practitioners together strengthening the networking between countries in the region

The two participants that scored this question as 'unsure' felt the goals or outcomes were unclear. Another couple of participants also made the comment that arthropod pests were not covered as well as weeds.

The final three questions are listed below with a summary of the answers that reflect all that were given.

What did you learn at the workshop?

- Why biocontrol is important for Pacific Islanders
- Contacts in the Pacific and donor countries – lots of experience and skills to draw on
- Biocontrol history, successes and experiences
- Lots of biocontrol success stories in the Pacific
- Biocontrol agents for Pacific pests and weeds are available to share
- Current projects and opportunities for collaboration
- Where PIs continue to lack skills, capacity and resources
- Lots being done, but lots more to do in biocontrol in the Pacific
- Funding opportunities

- Identifying top pests
- How other countries approach biocontrol
- One participant made the comment that there was a low level of Pacific Island country input and a dominance of biocontrol experts

What will you do to help foster a Pacific-wide co-operative approach to biocontrol?

- Encourage projects
- Encourage development of collaborative projects
- Make sure BCAs are shared between countries
- Share ideas and specialists to prevent exotic pests from spreading
- Consult with contacts made to save time and confusion
- Spread the good news of biocontrol – increase awareneness
- Collaborate with and help more with others
- Follow through on specific project ideas
- Be active member of biocontrol strategy coordination committee
- Continue networking with other BC practitioners
- Represent my country/region in BC issues and participate in working groups
- Provide technical expertise to the region
- Organise technical training for appropriate staff
- Ensure Pacific partners are well represented at ISBCW13 in 2011

What was the most important outcome of this workshop?

- List of actions
- Getting together as a group – networking
- Coming up with good project ideas
- Meeting scientists involved in different aspects of biocontrol from different countries
- Identifying BCAs of pests and weeds
- Prioritising weeds and pests
- Biocontrol is still growing in the Pacific
- Identifying funding sources

- Biocontrol success stories
- Regional project coordination
- To learn about possibilities that can be adopted in my country
- Sharing and working together to achieve goals
- The ant – hemiptera programme
- Re-establishing Hawaii's involvement in the region
- Creation of the steering committee to move initiatives forward
- Emphasis on public awareness
- Participation in decision making on target selection and biocontrol
- Framework for maintaining discussions and developing cooperation's in the future

Appendix 11

Media releases from Biocontrol Strategy Workshop

Natural enemies to fight invasive species – Emil Adams (SPC)

A regional workshop on biocontrol heard that in the Pacific between 300 and 500 plant species could be regarded as invaders with about 150 species classified as aggressive and impacting one way or the other. Miikania micrantha, or mile-a-minute, so called because it can grow as fast as one meter per month, is one of these aggressive weed species; it is found in 14 Pacific islands. Farmers spend a lot of time clearing land of this weed and many other introduced invasive alien plants. Such alien plants can also suppress forest regeneration or change the ecology of many areas.

The Pacific Biocontrol Strategy Development Workshop is currently being held in Auckland, New Zealand. SPC technical staff from the Land Resources Division, lead by Mr Warea Orapa, Plant Health Coordinator is collaborating with LandCare New Zealand and the United States Forest Service in Hawai'i to hold the event. Plant health and quarantine specialists from Fiji, Cook Islands, Palau, Guam, Commonwealth of the Northern Marianas Islands, Federated States of Micronesia, American Samoa, Samoa, Niue, Solomon Islands, Papua New Guinea, and Tonga, as well as scientists from New Zealand, Australia, the Hawai'i (United States), and the United Kingdom are also attending the workshop being held at Waipuna Hotel, Auckland, 16-18 November, 2009. The workshop aims to develop a regional strategy for implementing biological control work in the Pacific.

"The Pacific region was the first in the world to use biological control for weed and insect pest management due to the proximity to Hawaii and Australia, the early centers for pest management using this technique. Due to the general lack of capacity biological control as a pest management tool is restricted to only a few Pacific island countries and territories and is a service most useful if resources are pooled together.

"SPC is coordinating with the Pacific island countries to build capacity in biocontrol as a pest management tool. Some of the weeds and insect pests affecting the Pacific islands are very invasive and widespread and threaten Pacific island livelihoods. Use of chemicals to control pest and weed problem is not feasible, so we go look for natural enemies to fight the weed pest. In most cases there is a natural enemy somewhere that can control the weed or pest. We then start the technical process of importing the biocontrol for rearing and releasing in countries with the problems.

"Coming back to the mile-a-minute weed problem, SPC through international cooperation have identified three natural enemies to control this aggressive vine. Two butterfly species, Actinote anteas and Actinote thaliapyrrha, and a rust-causing fungus, Puccinia spegazzini,which attacks mikania leaves, are being planned as the weapon against the weed in Fiji and Papua New Guiena. The two butterflies were introduced from Indonesia where they are already being used to control mikania. They have been host-tested to ensure they do both harm other useful plants when released in the wild. This is a very important step in the introduction of biological control agents," said Orapa.

The mikania biocontrol work is a collaborative research initiative funded jointly by the Australian Centre for International Agricultural Research (ACIAR). The Project is helping train national staff in the skills of weed biocontrol work. Biocontrol is expected to keep populations of weeds and pests at low densities in Fiji and PNG. Results from this project have the potential to benefit many other Pacific island countries and territories.

Another project, the Biological Control of Chromolaena Project in PNG is a related project that ACIAR funded and the PNG National Agricultural Research Institute and Queensland Department of Primary Industries has implemented until 2008. "Chromolaena is classified as Class One weed for Queensland as it has the potential to spread and cause huge problems in Australia", said Michael Day, a biological control scientist who works with the Queensland DPI and attending the Pacific Biocontrol Strategy Development Workshop here in Auckland.

Mr. Day reported that three biocontrol agents including a very useful gall-forming fly were introduced into Papua New Guinea from Guam, the Philippines and South Africa between 1998 and 2004 to stop the alien weed from spreading and causing socio-economic and environmental damage. These insects are helping to control weeds in many areas in PNG.

In the Cook Islands a ladybird beetle is helping control the coconut scale insect Aspidiotus destructor. Originally introduced from Australia in 1991, the ladybird beetle is now the weapon of choice to fight scale insects in the remote Northern Group where the latter have become a food security threat. A recent heavy infestation of the coconut scale insect on Pukapuka island in the Northern Cooks became a real threat to food security as coconuts form the main stable food item" reported Dr. Maja Poeschko, an entomologist of the Cook Islands Ministry of Agriculture. She was able to beat logistics problems and ship the ladybird biocontrol across to Pukapuka where communities are now using them to reduce populations of the pest scale insect.

Forests in Fiji, Samoa, Tahiti and eastern PNG are quickly being smothered by introduced African tulip trees which are competing with indigenous forest trees and plants. African tulip has no economic value to date and is dangerous in urban areas where it could break over and kn down power lines, buildings or kill people. Following recommendations from Pacific Island governments, SPC is looking at finding biological solutions to addressing this through international collaboration with scientists in African and elsewhere, according to Orapa.

"Biocontrol, or biological control, is the use of highly evolved and host-specific natural enemies in weed or pest management. It is very friendly to the environment, helps preserve the natural biodiversity of island ecosystems and is in the long run the most less costly and sustainable method of pest control" says Orapa.

The workshop expects to finish on Wednesday with a regional strategy and plans for the immediate, medium and long term on how the region can utilize this useful technology in agriculture, forestry and environment management.

For more information, please contact WareaO@spc.int.

Sharing knowledge on biocontrol expertise amongst Pacific Islands – Emil Adams (SPC)

Pacific Islanders joined plant health experts from the international community in grappling with the issue of adopting biological control as a tool in fighting invasive pests in agriculture, forestry and environmentally important systems. Biocontrol uses highly evolved and host-specific natural enemies to lower the population of pests affecting agriculture and the natural ecosystem. Pacific Island countries and territories (PICTs) can share more information between agriculture, forestry and biodiversity conservation groups to better address biocontrol work, as well as looking at strategies implemented in other regions in the use of biocontrol agents to fight invasive plants and pests.

These were some of the issues discussed during the second day of the Pacific Biocontrol Workshop currently underway in Auckland, New Zealand. Over 40 delegates are attending the workshop, including 10 from PICTs. The workshop aims to develop a regional strategy for implementing biological control work in the Pacific.

Value adding is usually associated with trade and the process of downstream processing to improve the value of agricultural produce. However, it is just as applicable to weed biocontrol, where it refers to moving biocontrol agents from one place to another. For instance, biocontrol agents released for weed control in Papua New Guinea or Australia can be moved to other parts of the Pacific to control the same weed.

'Moving safe biocontrol agents from one PICT to another, or between islands within a country, is a simple, cheap and fast way of developing biological control. It allows current projects to be extended to other countries, and especially for weeds there is a high potential for biocontrol,' said Mic Julien of Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) in his presentation to the biocontrol workshop.

Water hyacinth (Eichhorniae crassipes) provides a classic example. A tiny beetle, Neochetina eichhorniae, released in Papua New Guinea (PNG) in the mid-1990s, was effective in controlling this serious weed in waterways and has been introduced in Vanuatu, where it has helped reduce problems caused by the weed in rural areas. Previously clogged fresh waterways, including streams and lakes, are now cleared of water hyacinth, and this has helped native fauna and flora return to their original levels. Communities benefit because they can once again use their canoes in these waterways to travel and fish.

'We can also use known biocontrol agents from other countries outside the region and introduce them to PICTs to control the same problematic species. There are known biocontrol agents for giant sensitive weed, Mimosa pigra, in Australia, and they can be introduced into PNG, or useful diseases for the pasture weed noogoorra burr to control the same weed in Fiji,' said the CSIRO scientist.

Current research in other countries can benefit the Pacific as well. The banana passionfruit is an invasive weed in New Zealand and some PICTs. Current research in identifying a biocontrol agent for New Zealand for this weed can benefit PICTs as well.

PICTS face particular challenges in biocontrol work. Frequent tropical cyclones and typhoons and the impact of climate change often impact negatively on biocontrol agents. Limited expertise, financial resources and quarantine facilities for biocontrol work are other major challenges. Inadequate resourcing has often been identified as one of the reason for failures in biocontrol work. However, biological control is often the only logical response to invasive insect or weed pests for the Pacific. Rural Pacific communities have traditional knowledge of natural enemies of weed and insect pests and can contribute to strategies on managing invasive species.

The Pacific Biocontrol Strategy Development Workshop is a collaborative effort between SPC's Land Resources Division, Landcare Research in New Zealand, the United States Forest Service in Hawai'i and the Pacific Invasives Learning Network based at SPREP. Scientists and plant protection experts and information managers on Pacific invasive species are attending the workshop to identify and address issues related to biological control of weeds and insect pests affecting agriculture, forestry and biodiversity.

For more information, please contact SPC Plant Health Coordinator Warea Orapa at WareaO@spc.int







PART 2

Prioritisation of Pacific weed targets for biological control

Prioritisation of targets for biological control of weeds in the Pacific region

Quentin Paynter

Landcare Research

Prepared for:

Critical Ecosystem Partnership Fund and USDA Forest Service

July 2010

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Landcare Research Contract Report: LC0910/190

Summary

Project and Client

Invasive weeds are one of the most serious threats to biodiversity and sustainable development in the Pacific region. Biocontrol is likely to be the only feasible way of managing many widespread weeds, but is not always appropriate or successful. With so many weed species to tackle and inevitably limited resources, prioritising where to direct control efforts most effectively is of key importance. Landcare Research recently developed a framework for the Australian government that allows the best and worst weed targets for biocontrol to be identified. Critical Ecosystem Partnership Fund and USDA Forest Service International Programs funding enabled this framework to be applied to weeds of the Pacific region.

Objectives

To apply a framework developed for Australia by Paynter et al. (2009) to prioritise biocontrol targets from a list of 96 weed species identified during a Pacific-wide biocontrol workshop held in November 2009 (Dodd & Hayes 2009) for 15 regions/nations – Micronesia, New Guinea, Solomon Islands, Vanuatu, New Caledonia, Fiji, Tonga, Tuvalu, Tokelau, American Samoa, Samoa, Cook Islands, French Polynesia, Pitcairn Islands, and Hawaii – as follows:

Acquire information regarding traits of each weed that Paynter et al. (2009) showed were correlated with the impact and cost of biocontrol and review current and past biocontrol programmes against the 96 weeds listed by Dodd and Hayes (2009).

Score and list prioritised weed biocontrol targets using the Paynter et al. (2009) framework, according to the predicted impact of biocontrol (feasibility) and effort required to conduct a biocontrol programme and overall score (feasibility score × 1/effort score).

Methods

Relevant data to parameterise the Paynter et al. (2009) scoring framework were acquired by using international scientific literature (e.g., CAB Abstracts®), regional floras, relevant websites (e.g. the Pacific Island Ecosystems at Risk (PIER) website http://www.hear.org/pier/ and Wikipedia http://www.wikipedia.org/ and by consulting with regional experts.

The project brief was to assess the priority of each species using the framework for 15 countries/territories: Micronesia, New Guinea, Solomon Islands, Vanuatu, New Caledonia, Fiji, Tonga, Tuvalu, Tokelau, American Samoa, Samoa, Cook Islands, French Polynesia, Pitcairn Islands, and Hawaii. Not all weeds were present in all countries/territories. Moreover, cost and probability of biocontrol success should vary, for example, according to the presence or absence of related species, which also vary between countries/territories. Rather than conducting a single prioritisation analysis covering all these countries/territories it was therefore decided to group the 15 countries/territories into four regions with similar floras and weed problems:

- North-west: including New Guinea, Micronesia & the Solomon Islands
- Central: including New Caledonia, Vanuatu, Fiji, Tuvalu, Samoa, American Samoa & Tonga
- North-east: Hawaii
- South-east: Cook Islands, French Polynesia & Pitcairn Islands.

The history of biocontrol throughout the Pacific region was then reviewed to identify and prioritize biocontrol targets within these four regions.

Results

Information was found for most of the relevant attributes for all the weed species, enabling feasibility of biocontrol, effort and overall scores (based on both the feasibility and effort required to implement biocontrol) to be calculated for all weed species. These scores are listed in Appendices 4–15.

Conclusions

Ideally, weeds should be prioritised on the basis of importance, as well as the potential cost and feasibility of biocontrol. The relative importance of the 96 weeds in each region has not been rigorously determined. Moreover, many of the 96 weed species were introduced because of perceived beneficial properties (e.g., ornamental, edible fruits or source of timber). The assumption made during this ranking exercise is that the negative aspects of the invasive weed outweigh these benefits, which may not be the case. It is therefore premature to make recommendations regarding the precise order of priority with which weeds should be targeted for biological control. Nevertheless, firm recommendations can be made regarding the redistribution of proven agents, and weed species are identified that are likely to be the most feasible novel targets for biocontrol, provided they are appropriate targets for biocontrol (i.e. that conflicts of interest are unlikely to prevent biocontrol from being implemented).

Recommendations

There is considerable scope for redistribution of existing, proven biocontrol agents for some of the worst weeds in the Pacific region (listed in the report).

A number of current weed targets for biocontrol where agents have not yet been released or where agents have been released but it is too early to evaluate the impact of biocontrol, are predicted to be good targets (*Coccinia grandis*, *Hedychium* spp. and *Psidium cattleianum*) or intermediate targets, (*Miconia calvescens, Mikania micrantha, Tecoma stans*), in terms of feasibility of success. This ranking exercise therefore supports the nomination of these species as targets for biocontrol in the Pacific region.

A number of weeds that are serious problems in the Pacific but have never been targeted for biocontrol were identified as good targets in terms of feasibility of success, (*Antigonon leptopus*, *Clerodendrum chinensis*, *Spathodea campanulata*, and *Sphagneticola trilobata*), while others were consistently identified as difficult targets (*Bidens pilosa*, *Cyperus rotundus*, *Mimosa pudica, Passiflora* spp., and *Senna tora/ obtusifolia*).

Conflicts of interest can delay or even prevent biocontrol programmes from proceeding. The assumption made during this ranking exercise is that the negative aspects of the invasive weed outweigh these benefits, which may not be the case. Another important aspect of prioritisation is weed importance. Determining the relative importance of the 96 weed species was beyond the scope of this ranking excercise. Decisions regarding whether a weed is an appropriate target, in terms of both importance and potential for conflicts of interest, must be made by the appropriate authorities in the relevant regions.

As noted by Paynter et al. (2009), there is a risk that if the framework is used as the only tool for prioritisation, then it may become a self-fulfilling prophesy. If conventional wisdom states that biological control cannot succeed against a particular weed type, then it may result in that weed type never being targeted for biological control. Weeds that do not fall in the top 20 should still be considered for biocontrol if they are of importance to countries, as projects against more difficult targets can still succeed, but they just might require more resources. We recommend an integrated pragmatic decision-making process to stand alongside the framework, which will serve to deliver a portfolio of weed targets that includes a range of good, medium and hard weed management targets.

The author is interested to receive any additional information about Pacific weeds or biocontrol programmes that was not available at the time of writing this report. He is also available to assist individual Pacific Island countries and territories to further refine and customise prioritised lists of the best weed biocontrol targets. He can be contacted on paynterq@landcareresearch.co.nz.

Introduction

Invasive species are considered to be one of the most serious threats to biodiversity and sustainable development in the Pacific region, which includes recognised biodiversity hotspots, such as New Caledonia and Polynesia-Micronesia. Invasive species are a growing problem in the Pacific as global trade, travel and tourism bring increasing numbers of invasive species to the Pacific, and troublesome species that are already present begin to naturalise and move out of lag phases. Better and more sustainable ways of combating invasive species are urgently needed.

Biocontrol is likely to be the only feasible way of managing many widespread weeds. Biocontrol is, however, not always appropriate or successful, and with so many species to tackle and inevitably limited resources, prioritising where to direct control efforts most effectively is of key importance. Landcare Research recently developed a framework for the Australian government that allows the best and worst weed targets for biocontrol to be identified (Paynter et al. 2009). This framework scored weed targets on the basis of their amenability to biological control (feasibility) and the likely effort required to implement a biological control programme. To determine a weed's amenability to biocontrol Paynter et al. (2009) investigated a range of weed attributes that were hypothesised to be associated with biocontrol success. Data on the impact of biological control were collected in a variety of ways (e.g., percentage cover; stems m^{-2}; weed biomass). To allow comparison between weeds, these data were converted into an 'impact index' (I), defined as the proportional reduction in weed density due to biological control. A scoring system was then developed that scored a weed according to attributes that were statistically significant indicators of impact index, namely:

- Previous success or failure, if the weed had been already been targeted for biocontrol elsewhere (because successes/failures are often repeated);
- Habitat (mean impact of biocontrol against aquatic and wetland weeds is significantly greater than against terrestrial weeds);
- Life cycle (mean impact of biocontrol against temperate annuals was significantly lower, compared with tropical annuals, biennials and perennials);
- Reproduction (mean impact of biocontrol against species capable of vegetative reproduction was greater versus weed species reproducing solely by seed);
- Weed in native range (biocontrol impacts against species reported to be weeds in the native range were significantly lower, versus species not reported to be weeds in the native range);
- Difficulty targeting multiple forms of weed, or probability of replacement of the weed by forms or congeners of the target following successful biological control thereby negating benefits (for example, species with multiple closely related forms, such as *Rubus fruticosus* agg. and *Lantana camara* are notoriously difficult targets, because biocontrol may only be effective against a limited subset of forms);
- Growing in competitive environment (agricultural versus environmental weed, because the mean impact of biocontrol on agricultural weeds was lower versus environmental weeds);
- Presence of a native or valued exotic congener to the weed. Even though this was not a significant factor influencing past success, Paynter et al. (2009) included it because when many past programmes were conducted, the risk of non-target attack on native plants was only a minor

consideration. Consequently, a number of weed biocontrol agents were released that have been recorded attacking non-target plants. Subsequent concerns regarding non-target attack have resulted in increasingly risk-averse policies and fewer successful applications for the release of weed biocontrol agents. It is likely that past successful programmes against a number of weeds (e.g., the programmes against *Carduus nutans* and *C. acanthoides* in the USA; *Hypericum perforatum* in Australia, South Africa and the USA) would not be possible if they were current targets, due to the presence of native congeners and the potential for non-target attack.

The "Feasibility" score was given a maximum value of 100. Paynter et al. (2009) validated the scoring system by correlating feasibility score with impact index (Figure 1). The impact of biocontrol against weeds that scored >70 was invariably high; while impacts against weeds that scored $\leq$ 50 was almost invariably low. Programmes against weeds that scored between 51 and 70 had similar numbers of successes and failures, allowing weeds to be categorised as good, difficult or intermediate targets according to the feasibility score.

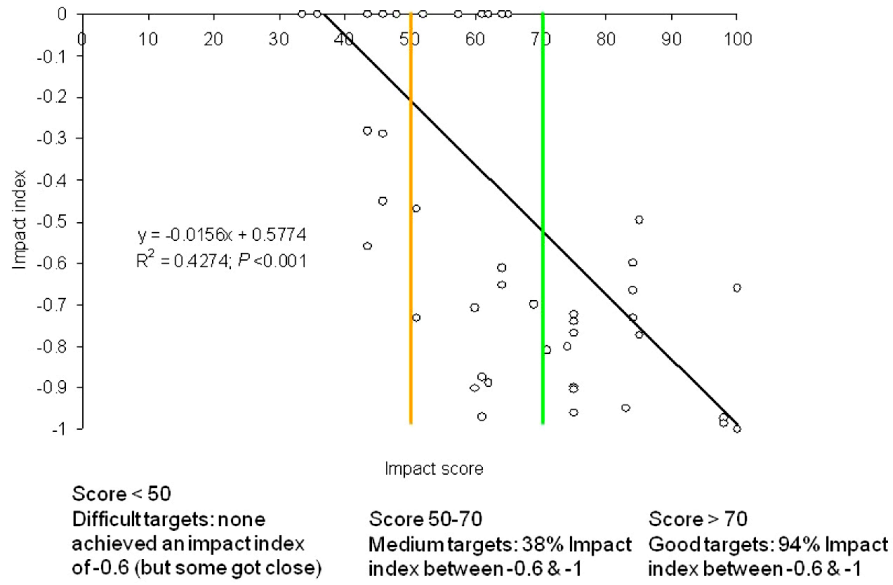

FIGURE 1 Biocontrol feasibility score versus actual 'impact index' (based on Paynter et al. (2009).

Paynter et al. (2009) determined the likely effort required to implement a biocontrol programme by reviewing factors that influence biocontrol programme cost. Factors influencing "effort" are listed below:

- Whether the weed had already been targeted for biocontrol elsewhere
- Access and ease of working in the native range
- Literature regarding natural enemies well known
- Presence of native or valued exotic plants that are related to the target weed

The biggest determinant of cost was whether a programme had already been conducted successfully elsewhere, because native range surveys and much, if not all, of the host-range testing required would have already been performed. For pioneering programmes, factors associated with cost include the risk of non-target attack: the average duration of host-range screening is longer for agents that attack weeds that are closely-related to native plants or valued exotic plants, compared to those which attack weeds that are unrelated to native or valued exotic plants. Other, less easily quantifiable determinants of effort include the ease of working (e.g., acquiring permits, travel and accommodation costs, quality of

infrastructure, safety) in the native range and knowledge of the fauna in the native range (for example, the insect fauna of European plants is so well known and documented that promising candidate agents can often be short-listed on the basis of host records alone).

The benefit to cost ratio of successful weed biocontrol programmes can be so high, the initial effort spent implementing biocontrol can seem trivial. Paynter et al. (2009), nevertheless, recognised that effort is important because, given limited resources, it may be economically prudent to tackle a higher number of "low effort" weeds versus fewer "high effort" weeds. Effort was therefore scored out of 50 (the higher the score the more effort required), recognising that while it is important, effort is less important than feasibility of control. The scoring system used by Paynter et al. (2009) is given in Appendix 1.

Paynter et al. (2009) noted that it is important to take into account a weed's importance as well as the feasibility of biocontrol. For example, the economic or environmental benefits of partially controlling a major weed might exceed the benefits of completely controlling a minor weed. Paynter et al. (2009) incorporated weed importance by combining feasibility and effort scores with already published weed importance rankings for Australia (Thorp & Lynch 2000). The relative importance of weeds of the Pacific region has not been formally determined. Dovey et al. (2004) listed the top 24 potential candidate weeds for biological control in Pacific island countries and territories. Moreover, a Pacific-wide workshop of biocontrol experts held in November 2009 (Dodd & Hayes 2009) expanded this list by identifying 96 weed species that are of particular importance within the Pacific region. The Paynter et al. (2009) framework was therefore applied to rank these 96 weeds according to their likely amenability to biocontrol (feasibility) and the effort required to conduct a biocontrol programme. In addition to the 96 nominated weeds, *Cuscuta campestris* was also included because there was some concern that the similar parasitic weed *Cassytha filiformis*, which is native to the region, had been confused with the former species, which is an invasive weed throughout the Pacific region. *Senna obtusifolia* was also included, because this species has been confused with *Senna tora* (Jean Yves-Meyer, pers. comm.).

Methods

I used the framework developed by Paynter et al. (2009) to score and rank weeds according to their predicted susceptibility to biocontrol and the likely complexity and cost of a weed biocontrol programme as follows:

I acquired relevant data on those attributes that are statistically significant indicators of biocontrol success and the cost of implementing biocontrol (see Introduction). This included the current status of biocontrol programs for each of the 96 weed species, for which biocontrol is desired in the Pacific, that were identified at a Pacific-wide workshop (Dodd & Hayes 2009). These data were gathered by using international scientific literature (e.g., CAB Abstracts®), regional floras, the World Wide Web, especially the Pacific Island Ecosystems at Risk (PIER) website (http://www.hear.org/pier/) and Wikipedia (http://www.wikipedia.org/) and by consulting with regional experts.

Our brief was to assess the priority of each species using the framework for 15 countries/territories – Micronesia, New Guinea, Solomon Islands, Vanuatu, New Caledonia, Fiji, Tonga, Tuvalu, Tokelau, American Samoa, Samoa, Cook Islands, French Polynesia, Pitcairn Islands, and Hawaii. Conducting a single prioritisation analysis for these countries/territories could be misleading, because the probability of successful biocontrol should vary between them, for example, according to geographic variation in the presence of absence of native species that are closely related to the target weed. There were insufficient resources to conduct 15 separate ranking analyses so countries/territories were grouped into four regions (see Figure 2) with similar floras and weed problems as follows:

- **NORTH-WEST**: including New Guinea, Micronesia & the Solomon Islands
- **CENTRAL**: including New Caledonia, Vanuatu, Fiji, Tuvalu, Samoa, American Samoa & Tonga
- **NORTH-EAST**: Hawaii
- **SOUTH-EAST**: Cook Islands, French Polynesia & Pitcairn Islands.

FIGURE 2
The four regions that were analysed separately (see text for details).

Results and Conclusions

Information was found for most attributes for all the weed species and these are listed in Appendices 2 and 3. There was, however, little information pertaining to the presence of hybrids or multiple forms of weeds. This factor was generally scored as unknown, with the exception of a few weeds such as *Broussonetia papyrifera*, which exists as sterile male clones in the Pacific region, and biocontrol targets for which multiple weed forms have already been demonstrated to be a potential problem (e.g., *Lantana camara*) or not (e.g., *Eichhornia crassipes*). However, it is possible that the genetic diversity of weeds such as *L. camara* is different within the Pacific region, compared with other studied populations, which could affect the feasibility of biocontrol.

Many of the 96 weed species were introduced because of perceived beneficial properties (e.g., ornamental, edible fruits or source of timber). The assumption made during this ranking exercise is that the negative aspects of the invasive weed outweigh these benefits, which may not be the case. Certainly some species, listed as cultivated on the PIER website (http://www.hear.org/pier/) are no longer cultivated and may even be banned from cultivation (e.g., *P. cattleianum, S. cumini, S. jambos, S. campanulata, T. stans* and *L. camara* in French Polynesia; Jean-Yves Meyer, pers. comm.). However, other plants, such as *Acacia* spp., that are cultivated for timber, may not be appropriate targets for biocontrol. Therefore, weeds identified as potentially good targets for biocontrol, in terms of predicted impact/feasibility, may prove to be inappropriate targets due to the potential for conflicts of interest. These decisions have to be made by the appropriate authorities in the relevanAnother similar source of uncertainty was the importance of exotic congeners of the target weed, for the same reasons as above: it was not always clear whether a 'cultivated' exotic congener is still cultivated within the region. We assumed that, as in New Zealand, economic considerations mean that non-target attack on exotic ornamental congener species is acceptable, but that non-target attack on valued exotic agricultural congeneric crops is unacceptable.

The feasibility, effort and combined scores for the twenty best targets (based on combined feasibility and effort scores) are listed for the four regions (Appendices 4–15).

Potential for repeat programmes and collaborative programmes

As expected, many of the best targets are species for which biocontrol has succeeded in other countries. Some of these species have already been targeted for biocontrol within the Pacific region. Nevertheless, as noted by Julien et al. (2007), there are numerous opportunities for redistribution of biocontrol agents that are already present in the Pacific. For example, *Heteropsylla spinulosa* has successfully controlled *Mimosa diplotricha* in many parts of Pacific, but has not yet been introduced in French Polynesia, New Caledonia or Vanuatu. Although biocontrol has succeeded against *Eichhornia crassipes* in many countries, in the Pacific region it has, to date, only been targeted for biocontrol in Papua New Guinea, Fiji and Vanuatu (Dodd & Hayes 2009). In addition, there are weeds such as *Parthenium hysterophorus* and *Xanthium strumarium* that have been successfully targeted for biocontrol outside the region for which agents have yet to be released in the Pacific region.

Several weeds are current biocontrol targets, although biocontrol agents have not yet been released against them. These species have lower effort scores, because native range surveys have already been

performed and, in some cases such as *Tecoma stans*, host-range testing has been performed and specific candidate agents have been identified (Wood 2009). Weeds that have been targeted for biocontrol both within and outside the Pacific region are listed in Appendix 3.

Potential for novel targets

Although repeat programmes may incur a lower risk of failure, compared with tackling novel targets, novel programmes are required for weeds that are problems in the Pacific region and that have not been targeted for biocontrol elsewhere. The ranking system identified several such weeds as good targets for biocontrol, including *Antigonon leptopus, Psidium cattleianum, Sphagneticola trilobata* and *Spathodea campanulata* (see Appendices 6, 9, 12 and 15). *Costus speciosus, Merremia* spp. and *Stachytarpheta* spp. were identified as intermediate targets. Some serious weeds in the region were consistently identified as difficult targets, including *Bidens pilosa, Cyperus rotundus*, *Mimosa pudica* and *Senna tora/obtusifolia* (see Appendices 4, 7, 10 and 13).

Recommendations

It may be premature to make recommendations regarding which weeds should be targeted for biological control in this report, because the relative importance of each weed and the need for biocontrol in each region has not been rigorously determined (see Appendix 16, for information regarding determining weed importance). Nevertheless, on the basis of information presented by Dodd and Hayes (2009) a number of recommendations can be made with some confidence:

There is considerable scope for redistribution of existing, proven biocontrol agents, for some of the worst weeds in the Pacific region. A list of weeds for which proven biocontrol agents are available for redistribution throughout the Pacific region is provided in Table 1, below, but note that the list of regions where biocontrol is required list is considered to be incomplete. This is because at the meeting reported by Dodd and Hayes (2009), weed experts were not present from all the15 countries/territories included in this ranking excercise.

A number of current weed targets for biocontrol where agents have not yet been released or where agents have been released but it is too early to evaluate the impact of biocontrol, are predicted to be good targets (*Coccinia grandis, Hedychium* spp. and *Psidium cattleianum*) or intermediate targets, (*Miconia calvescens, Mikania micrantha, Tecoma stans*), in terms of feasibility of success. This ranking exercise therefore supports the nomination of these species as targets for biocontrol in the Pacific region.

A number of weeds that are serious problems in the Pacific but have never been targeted for biocontrol were identified as good targets in terms of feasibility of success (*Antigonon leptopus, Clerodendrum chinensis, Spathodea campanulata* and *Sphagneticola trilobata*). We recommend that biocontrol programmes against these weeds should proceed, provided there are no conflicts of interest.

Conflicts of interest can delay or even prevent biocontrol programmes from proceeding. The assumption made during this ranking exercise is that the negative aspects of the invasive weed outweigh these benefits, which may not be the case. Another important aspect of prioritisation is weed importance. Determining the relative importance of the 96 weed species was beyond the scope of this ranking excercise. Decisions regarding whether a weed is an appropriate target, in terms of both importance and the potential for conflicts of interest, must be made by the appropriate authorities in the relevant regions.

As noted by Paynter et al. (2009), there is a risk that if the framework is used as the only tool for prioritisation, then it may become a self-fulfilling prophesy. If conventional wisdom states that biological control cannot succeed against a particular weed type, then it may result in that weed type never being targeted for biological control. Weeds that do not fall in the top 20 should still be considered for biocontrol if they are of importance to countries, as projects against more difficult targets can still succeed, but they just might require more resources. We recommend an integrated pragmatic decision-making process to stand alongside the framework, which will serve to deliver a portfolio of weed targets that includes a range of good, medium and hard weed management targets.

The author is interested to receive any additional information about Pacific weeds or biocontrol programmes that was not available at the time of writing this report . He is also available to assist individual Pacific Island countries and territories to further refine and customise prioritised lists of the best weed biocontrol targets. He can be contacted on paynterq@landcareresearch.co.nz.

TABLE 1 List of weeds for which proven biocontrol agents are available for redistribution throughout the Pacific region. The areas where biocontrol is required are those listed by Dodd and Hayes (2009).

WEED	Where biocontrol is required
Chromolaena odorata	New Caledonia
Eichhornia crassipes	New Caledonia; Samoa
Lantana camara	Cook Islands; Samoa
Mimosa diplotricha	Cook Islands; French Polynesia; New Caledonia; Vanuatu
Mimosa pigra	Papua New Guinea
Parthenium hysterophorus	?
Salvinia molesta	Hawaii; New Caledonia
Sida acuta	Guam; Federated States of Micronesia; Niue; Samoa; Solomon Islands
Sida rhombifolia	Commonwealth of the Northern Mariana Islands; French Polynesia; Guam; New Caledonia; Samoa Solomon Islands
Xanthium strumarium	Fiji; Papua New Guinea

This list is considered to be incomplete because at the meeting reported by Dodd and Hayes (2009), weed experts were not present from all the15 regions/nations included in this ranking excercise. For example, nations where biocontrol of *Parthenium hysterophorus* is required were not listed by Dodd and Hayes (2009), but agents for this species have not yet been released in French Polynesia, Hawaii, New Caledonia or Vanuatu.

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Appendix 1

Scoring system for 'Effort' and 'Feasibility' used by Paynter et al. (2009).

	OUTCOME	SCORE
EFFORT REQUIRED TO OBTAIN & HOST-RANGE TEST BIOCONTROL AGENTS		
1. Has the weed been/is it a subject of adequately resourced biocontrol programme elsewhere?		
a. Yes, successful program	If specific agents are already known & host-range testing has already been conducted overseas, then programme is likely to be cheaper	1
b. Yes, unsuccessful program	Law of diminishing returns – if current known suite of agents is ineffective, finding new ones will be harder	15
c. Current target/too early/insufficient data to assess success elsewhere or variable success elsewhere	Potential for cost savings, but uncertainty factored into score	8
d No, never		20
2. Accessibility and ease of working in native range		
Difficult		5
Moderate		3
Easy		2
not applicable (if repeat programme)		1
3. Literature regarding natural enemies well known/accessible		
Yes		1
No	Formal identification of candidate agents (required for import/release permits) may be time consuming, delaying a program	5
4. Plant phylogeny: How closely related to indigenous/valued plants is the target weed?		
None in same family	Cheaper no-choice tests may be sufficient, larger pool of candidate agents	1
Same Family		10
Same Genus	More extensive host-range testing may be required, more species may require testing before a sufficiently specific species is identified	20
FEASIBILITY OF BIOCONTROL (LIKELIHOOD OF GOOD IMPACT)		
1. Has the weed been a subject of adequately resourced biocontrol programme overseas?	Successes are frequently repeated	
a. Yes, successful target overseas 1 or more occasions	Maximum score: do not go to next set of questions	100
b. Yes, but with varying degrees of success or partial success		

	OUTCOME	SCORE
i. Reason for partial/variable success known (e.g., agent only attacks certain forms of weed, or is restricted to certain habitats/climates) and considered unlikely to be a problem	Do not go to next set of questions	80
ii. Reason for partial/variable success unknown	Do not go to next set of questions	60
iii. Reason for partial/variable success known and considered likely to be a problem	Do not go to next set of questions	40
c. Unsuccessful target overseas only once		30
d. Unsuccessful target overseas more than once		20
e. Not a target elsewhere or too early to assess success of overseas program	Go to next set of questions	0
2. Habitat		
Aquatic/wetland	Higher probability of success	35
Terrestrial	Lower probability of success	14
3. Life cycle		
Predominantly temperate annual	Lower probability of success	3
Predominantly tropical/sub-tropical annual	Higher probability of success	4
Biennial/perennial	Higher probability of success	5
4. Reproduction		
Vegetative (+/- seed/spore)	Higher probability of success	25
Seed/spores only	Lower probability of success	10
5. Weed in native range		
Yes	Lower probability of success	3
No	Higher probability of success	10
6. Difficulty targetting multiple forms of weed, or probability of replacement of the weed by forms or congeners of the target following successful biological control thereby negating benefits.		
Likely	Lower probability of success	0
Unlikely	Higher probability of success	5
Unknown		2
7. Growing in competitive environment (agricultural vs environmental)		
Predominantly agricultural/rangeland	Lower probability of success	1
Predominantly environmental	Higher probability of success	5
Unknown/both equally		3
8. Native/valued exotic congener		
Yes		0
No		15

Appendix 2

Attributes of the 96 nominated weed species and *Cuscuta campestris*. Key: Country abbreviations: AS = American Samoa; CI = Cook Islands; CNMI = Commonwealth of the Northern Mariana Islands; Fi = Fiji; FP = French Polynesia; FSM = Federated States of Micronesia; G = Guam; H = Hawaii; K = Kiribati; MaI = Mariana Islands; MI = Marshall Islands; Na = Nauru; Ni = Niue; NC = New Caledonia; NG = New Guinea; P = Palau; PI = Pitcairn Islands; S = Samoa; SI = Solomon Islands; To = Tokelau; T = Tonga; Tu = Tuvalu;

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Acacia confusa (Fabaceae)	Both agricultural and environmental: CNMI, FSM, G, H, P	Asia	Timber: Mal; H, P
Acacia mearnsii (Fabaceae)	Both agricultural and environmental: CI, H	Australia	Timber: CI; H
Acacia melanoxylon (Fabaceae)	Both agricultural and environmental: H, NC	Australia	Timber: H; NC
Acacia spirobis (Fabaceae)	Both agricultural and environmental: regions affected not clear; certainly FP	Australia, NG, V, NC	Apparently not cultivated, but native to some islands
Adenanthera pavonina (Fabaceae)	Environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, Na, NC, Ni, P, PNG, S, SI, T, WF	India to NG; NC	Forage, ornamental, medicinal, timber: FP; G; MI
Ageratum conyzoides (Asteraceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, MI, Na, NC, Ni, P, PNG, S, SI, T, V, WF	Tropical America, especially Brazil; (SI)	?Medicinal: Fi; MI
Albizia chinensis (Fabaceae)	Both agricultural and environmental: FP, H, NC, S	Asia	?Ornamental: NC
Albizia lebbeck (Fabaceae)	Environmental: CNMI, CI, FSM, Fi, FP, G, H, NC, P, PNG, SI, T, WF	South Asia	Forage, medicine, wood: Mal; FSM; Fi; FP; G; NC; P; SI; T; WF
Albizia saman = *Samanea saman* (Fabaceae)	Environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, MI, Na, NC, Ni, P, PNG, S, SI, T	Neotropical	?Ornamental: AS; CI; FSM; Fi; FP; G; H; MI; Na; Ni; P; S, T
Antigonon leptopus (Polygonaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, PI, T	Mexico	Ornamental: CNMI; CI; FSM; Fi; FP; G; H; K; MI; Na; NC, Ni; P; PI; S; T
Ardisia elliptica (Myrsinaceae)	Both agricultural and environmental: CI, FP, H, PNG, S	India to NG	?Not cultivated
Bidens pilosa (Asteraceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, PI, S, SI, T, V, WF	South America	?Not cultivated
Broussonetia papyrifera (Moraceae)	Both agricultural and environmental: Regions affected unclear	East Asia	Soil stabilization, homegarden (bark for cloth & traditional medicine): T, Fi, S, culturally significant in H

V = Vanuatu; WF = Wallis and Futuna. Habitat: all weeds occur in terrestrial habitats, with the exception of the aquatic/wetland species *Eichhornia crassipes, Mimosa pigra* and *Salvinia molesta*; Lifestyle: A = annual; BP = biennial or perennial; Reproduction: V = capable of vegetative reproduction; S = reproduction by seed only; Weed in native range: Y = yes; N = no; Hy = Hybrids/multiple forms of weed: Y = yes; N = no; ? = unknown; [1]Confusion occurs between both *S. tora* and *S. obtusifolia*.

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
A. auriculiformis (NG); *A. simplex* (W Pacific to S). Acacias (e.g. *A. spirobis,* (see below), & A. koa) present V & H.	Acacias are widely planted	BP	S	N	?
See above	Acacias are widely planted	BP	S	N	?
See above	Acacias are widely planted	BP	S	N	?
See above	Acacias are widely planted	BP	S	N	?
No	No	BP	S	N	?
No	No	A	S	Y	?
No	Albizias widely planted	BP	S	N	?
No	Albizias widely planted	BP	S	N	?
No	Albizias widely planted	BP	S	N	?
No	No	BP	V	N	?
No	No	BP	S	N	?
Yes (e.g. in H)	No	A	S	Y	?
No	No	BP	V	N	N

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Cardiospermum grandiflorum (Sapindaceae)	Agricultural: CI, FP, H	Southern Mexico to Brazil	?Not stated: H
Cassytha filiformis (Lauraceae)	Both agricultural and environmental: Regions affected unclear, confused with Cuscuta?	Pantropical: native throughout Pacific, including H	Traditional uses etc
Cecropia obtusifolia (Urticaceae)	Both agricultural and environmental: CI, H	Tropical Americas	?Not cultivated
Cecropia peltata (Urticaceae)	Both agricultural and environmental: FP, NC	Caribbean & northern South America	?Not stated: NC
Cenchrus echinatus (Poaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, To, T, V, WF	North & South America (Soloman Islands)	Not cultivated
Cestrum diurnum (Solanaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, S, T, WF	West Indies	Ornamental: AS; Fi; FP; H; T; WF
Cestrum nocturnum (Solanaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, PI, S, T, WF	West Indies	Ornamental: AS; Fi; FP; G; H; K; MI; Na; NC; Ni; S
Chromolaena odorata (Asteraceae)	Both agricultural and environmental: CNMI, FSM, G, MI, P, PNG	North America & to N. Argentina	Not cultivated: FSM Kosrae Island
Clerodendrum chinense (Lamiaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, H, Ni, PNG, S, T	S China & N Vietnam border regions	?Ornamental: CI; FSM; Fi; FP; H;
Clerodendrum japonicum (Lamiaceae)	Both agricultural and environmental: AS, H	Phillipines, NG	?Ornamental : AS
Clerodendrum quadriloculare (Lamiaceae)	Both agricultural and environmental: AS, CNMI, FSM, FP, G, H, MI, P, PNG, S	southern Asia	?Ornamental: AS; CNMI; FSM; FP; G; H; MI; P; S
Clerodendurm paniculatum (Lamiaceae)	Both agricultural and environmental: AS, FSM, Fi, FP, G, MI, Na, P, PNG, S, SI	India, China & Taiwan S to Malaysia	?Ornamental: AS; Fi; MI; Na; P
Clidemia hirta (Melastomataceae)	Both agricultural and environmental: AS, FSM, Fi, H, P, PNG, S, SI, V, WF	Neotropics	No
Coccinia grandis (Curcubitaceae)	Both agricultural and environmental: CNMI, FSM, Fi, G, H, MI, PNG, S, SI, T, V	Africa, Asia to NG	Edible: FSM; MI; S; T
Commelina benghalensis (Commelinaceae)	Both agricultural and environmental: CNMI, G, H, NC, PNG, S, SI, T, V	Old world tropics, including FSM; SI	No

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
No	No	BP	S	N	?
No	No	BP	V	Y	?
No	NC (*C. peltata)*	BP	S	N	?
No	No	BP	S	Y	?
C. agrimonoides (H); *C. caliculatus* (much of the Pacific)	Fi (*C. ciliaris)*	BP	S	Y	?
No	See next sp.	BP	S	N	?
No	See above	BP	S	N	?
No	No	BP	S	Y	Y
C. inerme: NG, MI, V, Fi, NC, SI	See next 3 spp.	BP	V	N	?
C. inerme: NG, MI, V, Fi, NC, SI	See above	BP	V	N	?
C. inerme: NG, MI, V, Fi, NC, SI	See above	BP	S	N	?
C. inerme: NG, MI, V, Fi, NC, SI	See above	BP	S	N	?
No	No	BP	S	N	N
No	No	BP	V	N	N
C. diffusa is described as native to some islands by PIER, but must surely be an ancient introduction	No	BP	V	Y	?

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Costus speciosus (Zingiberaceae)	Environmental: AS, CI, FSM, Fi, FP, G, H, MI, NC, Ni, P, PNG, S, SI, T, WF	S E Asia & Pacific (e.g. FSM; G; NG; P & ?NC); not native Fi; CI; H	Ornamental: CI; Fi; FP; G; H; Ni; SI; WF
Cuscuta campestris (Convolvulaceae)	Agricultural: CI, FSM, Fi, FP, G, H, K, MI, NC, Ni, S	North America	No
Cyperus rotundus (Cyperaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, To, T, Tu, V, WF	Eurasia, including SI	No
Eichhornia crassipes (Pontederiaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, G, H, MI, Na, NC, P, PNG, S, V	South America	Ornamental: FSM; Fi; FP; MI; Na; NC; P
Epipremnum aureum (Epipremnum pinnatum 'Aureum') (Araceae)	Both agricultural and environmental: CI, FSM, Fi, FP, G, H, MI, Na, Nuie, P, PNG, S, SI, T	SE Asia to NG; SI	?Ornamental: CI; Fi; FP; G; H; MI; Na; Ni; P; S; T
Euphorbia hirta (Euphorbiaceae)	Agricultural: G; MI; FSM; Northern MaI, H, CI, FP, PI, K	Southern USA to Brazil	No
Falcataria moluccana (Fabaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, G, H, NC, Ni, P, PNG, S, SI, T, WF	Africa, to NG: ?Bismark Archipelago, SI	Pulp wood: FSM; Fi; FP; H; NC; Ni; T; WF
Hedychium coronarium (Zingiberaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, G, H, Na, NC, P, S, T, WF	Himalayas region of Nepal & India	Ornamental: AS; CI; FSM; Fi; FP; G; H; MI; Na; NC; P; S, T; WF
Hedychium flavescens (Zingiberaceae)	Both agricultural and environmental: AS, CI, Fi, FP, G, H, NC, Ni, S, T	Himalayas, Eastern India	Ornamental: AS; CI; FP; H; NC; Ni
Hedychium gardnerianum (Zingiberaceae)	Both agricultural and environmental: CI, Fi, FP, H, NC	Eastern India	Ornamental: CI; Fi; H; NC
Imperata cylindrica (Poaceae)	Both agricultural and environmental: AS, CNMI, FSM, Fi, G, NC, S, T, V	Africa, Asia, Micronesia, SI, Australia	No
Ischaemum polystachyum var. chordatum (Poaceae)	Both agricultural and environmental: CNMI, FSM, G, P, PNG, SI	Phillipines, to NG & Polynesia: Considered native throughout the pacific region	No
Ischaemum timorense (Poaceae)	Both agricultural and environmental: AS, FSM, Fi, P, PNG, S	India to Polynesia, but considered exotic in H	No
Kyllinga polyphylla (Cyperaceae)	Agricultural: FSM, Fi, FP, NC, SI, To, V	Tropical east Africa, Mauritius	No
Lantana camara (Verbenaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, PI, S, SI, T, Tu, V, WF	South America	Ornamental: AS; Rapa Nui; FSM; FP; G; H; K; MI; Na; NC; P; S

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
No?	No	BP	V	Y	?
C. australis, (PNG ?NC); *C. sandwichiana* (H)	No	A	S	Y	?
Yes	?	BP	S	Y	?
No	No	BP	V	Y	N
No	No	BP	V	Y	?
E. tannensis (V, NC); *E. haeleeana* (H); *E. sachetiana* (Marquesas)	Yes e.g. *Euphorbia pulcherrima*	A	S	Y	?
No	No	BP	S	N	?
No	Yes	BP	V	N	?
No	Yes	BP	V	N	?
No	Yes	BP	V	N	?
No	No	BP	V	Y	?
I. byrone (H); *i. Indicum* (FSM; WF); *I rugosum* (P; G); *I timorense* (NG; P; FSM); *I. muticum* (NG; NC)	*I. Indicum* is ciltivated in Fi; Ni	BP	V	Y	?
see above	*I. Indicum* is ciltivated in Fi; Ni	BP	V	Y	?
K. brevifolia native to much of the Pacific (not Fi; MI; FP); genus not native to H or Marquesas	No	BP	V	Y	?
No	*L. montevidensis* is cultivated in Fi; FP; H; SI; WF	BP	S	N	Y

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Leucaena leucocephala (Fabaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, PI, S, SI, T, Tu, V, WF	Mexico, Guatemala, Belize	Fodder, firewood: H; MI; SI; PI
Melinis minutiflora (Poaceae)	Both agricultural and environmental: AS, CNMI, Fi, FP, G, H, NC, Ni, P, T, V, WF	Africa	?Not stated: Fi; G; NC; WF
Merremia peltata (Convolvulaceae)	Both agricultural and environmental: AS, CI, FSM, Fi, FP, G, MI, NC, Ni, P, S, SI, T, WF	SE Asia, considered native to parts of the Pacific region, but may be an early introduction	No
Merremia tuberosa (Convolvulaceae)	Both agricultural and environmental: CNMI, FSM, Fi, FP, G, H, K, MI, NC, Ni, S	Probably Tropical Americas	Ornamental: CI; Fi; G; H; K; NC; S
Miconia calvescens (Melastomataceae)	Both agricultural and environmental: FP, H, NC	Mexico to Argentina	?Not stated: H; NC
Mikania micrantha (Asteraceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, MI, NC, Ni, P, PNG, S, SI, To, T, Tu, V, WF	Central & South America (SI)	No
Mimosa diplotricha (Fabaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, NC, Ni, P, PNG, S, SI, V, WF	Brazil	?Not stated: Listed as cultivated in Fi; NC
Mimosa pigra (Fabaceae)	Both agricultural and environmental: PNG	Mexico to N. Argentina	No
Mimosa pudica (Fabaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, MI, Na, NC, Ni, P, PNG, S, SI, To, T, V, WF	South America	No
Ocimum gratissimum (Lamiaceae)	Agricultural: CI, FSM, Fi, FP, G, H, NC, S, T, V	Pantropical, native origin ?, widely naturalized	?Not stated: Rapa Nui
Panicum maximum (Poaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, NC, Ni, P, PNG, S, SI, T, V, WF	Africa	Fodder: FSM ; Fi; G; H; NC; T
Panicum repens (Poaceae)	Both agricultural and environmental: CNMI, H, P	Europe, Africa, Asia to CNMI; P	No
Parthenium hysterophorus (Asteraceae)	Agricultural: FP, H, NC, V	Mexico, Central & South America	Not cultivated: Described as cultivated in FP
Paspalum conjugatum (Poaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, MI, NC, Ni, P, PNG, PI, S, SI, T, Tu, V, WF	Tropical America	No

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
No		BP	S	N	?
No?	*M. repens* cultivated in Fi; G; NC	BP	V	N	?
M. pacifica is found in the Louisiade Archipelago (NG), Solomons, V, Fi	*M. dissecta* cultivated in Fi; *M. tuberosa* below; *M. umbellata* Fi; H	BP	V	Y	?
Yes	see above	BP	V	N	?
No	No	BP	S	N	?
M. cordata (NG, SI & S)	No	BP	V	N	?
No	No	BP	S	Y	N
No	*M. diplotricha* listed as cultivated in Fi; NC	BP	S	N	?
No	*M. diplotricha* is listed as cultivated in Fi; NC	BP	S	Y	?
No	*O. basilicum* cultivated in CNMI; CI; Fi; FP; G; H; K; Na; Ni	BP	S	?	?
P. repens is considered native to N & N-central Pacific (e.g. Saipan); H has several endemic spp	*P. antitotale* cultivated in Fi	BP	S	Y	?
see above	*P. antitotale* cultivated in Fi	BP	V	Y	?
No	No	A	S	Y	?
P. scrobiculatum (northern Marianas, FSM, FP, SI, T, WF, Na, probably native in H); *P. vaginatum* (CI, ?Marquesas); P. fimbriatum (SI)	*P. dilatatum* is cultivated in G; NC	BP	V	Y	?

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Paspalum distichum (Poaceae)	Both agricultural and environmental: CNMI, FSM, Fi, FP, G, H, K, MI, P	Probably tropical America, but listed as native in many Pacific areas: CNMI; FSM; Fi; FP ; G; MI; P	No
Paspalum urvillei (Poaceae)	Both agricultural and environmental: AS, CNMI, CI, Fi, FP, G, H, NC	Tropical Americas	?Fodder: G; NC
Passiflora foetida (Passifloraceae)	Environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, Na, NC, Ni, P, S, SI, T, V, WF	Tropical Americas (SI)	No
Passiflora laurifolia (Passifloraceae)	Environmental: CI, Fi, FP, H, Ni, PI, S, T	West Indies & South America	Edible: CI; Fi; FP; H; Ni
Passiflora ligularis (Passifloraceae)	Environmental: CI, FP, H, S	Andes of S America	Edible: CI; FP; H
Passiflora quadrangularis (Passifloraceae)	Environmental: AS, CI, FSM, Fi, FP, H, NC, Ni, P, S, SI, T	South America	Edible: FSM; Fi; FP; H; NC; Ni; SI; T
Passiflora rubra (Passifloraceae)	Environmental: CI	South America	No
Passiflora tarminiana (includes P. tripartita & P. mollissima) (Passifloraceae)	Environmental: G, H	Tropical America	No
Pennisetum clandestinum (Poaceae)	Both agricultural and environmental: H, NC, PNG, WF	Tropical Eastern Africa	Fodder: H; NC; WF
Pennisetum polystachion (Poaceae)	Both agricultural and environmental: CNMI, FSM, Fi, FP, G, H, K, MI, SI, V	Tropical Africa to India	Fodder: Fi;
Pennisetum purpureum (Poaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, NC, Ni, P, PNG, S, SI, To, V, WF	Tropical Africa	Fodder: Fi; FP; G; H; MI; NC; SI; WF
Pennisetum setaceum (Poaceae)	Both agricultural and environmental: Fi, G, H, NC, P	North Africa	Fodder: Fi; G; H; NC; P
Piper aduncum (Piperaceae)	Both agricultural and environmental: Fi, H, PNG, SI	Tropical America	No
Piper auritum (Piperaceae)	Both agricultural and environmental: FSM, H, S, T	Mexico, Central America, northern South America & West Indies	Edible: FSM; H
Psidium cattleianum (Myrtaceae)	Both agricultural and environmental: CI, FSM, Fi, FP, H, NC, P, PI, S	Mexico to northern South America	Edible: CI; FP; H; NC

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
see above	See above	BP	V	Y	?
see above	Yes	BP	S	Y	?
P. aurantia (NG, V, NC, Fi, S, T Ni); *P. barclayi* (NC, Fi)	Yes e.g. *P. edulis* in Fi; H; MI; Na; NC; Ni; P; SI; WF	BP	S	Y	?
see above	see above	BP	S	N	?
see above	see above	BP	S	N	?
see above	see above	BP	S	N	?
see above	see above	BP	S	N	?
see above	see above	BP	S	N	Y
No	Yes	BP	V	Y	?
No	Yes	A	S	Y	?
No	Yes	BP	V	Y	?
No	Yes	BP	S	N	?
P. methysticum is found throughout the Pacific, this genus is not present in H	Yes *P. auritum*, below; *P. lolot* FSM; *P. nigrum* in H (elsewhere??)	BP	S	N	?
see above	see above	BP	V	N	?
No	see below	BP	V	N	?

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Psidium guajava (Myrtaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, Na, NC, Ni, P, PNG, PI, S, SI, T, Tu, V, WF	Brazil	Edible: FSM; FP; G; H; K; MI; Na; NC; Ni; P; SI
Rottboellia cochinchinensis (Poaceae)	Agricultural: Fi, PNG, SI	Africa, Asia and Australia	No
Rubus argutus (Rosaceae)	Environmental: H	Central & eastern United States	No
Rubus ellipticus (Rosaceae)	Environmental: H	Tropical & subtropical India	Ornamental: H
Rubus glaucus (Rosaceae)	Environmental: H	Tropical Middle & South America: southern Mexico to Ecuador & Peru	No
Rubus moluccanus (Rosaceae)	Environmental: FSM, Fi, NC, PNG, SI, V	Himalayas through Malaysia to Australia, FSM; Fi; NC; NG; SI; V	No
Rubus niveus (Rosaceae)	Environmental: H	Asia	Edible: H
Rubus rosifolius (Rosaceae)	Environmental: FP, H, NC, PNG, SI	Asia, Australia, NG; SI; NC; V	No
Salvinia molesta (Salviniaceae)	Both agricultural and environmental: Fi, FP, H, NC, PNG, V	South east Brazil, N. Argentina	Ornamental: NC
Senna tora/S. obtusifolia (Fabaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, NC, Ni, PNG, S, SI, T, V, WF	India into Polynesia, but not indigenous east of Melanesia & perhaps not there	No
Sida acuta (Malvaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, T, V	Perhaps indigenous in Central America	No
Sida rhombifolia (Malvaceae)	Agricultural: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, PI, S, SI, To, T, V, WF	New world tropics & sub-tropics	No
Solanum torvum (Solanaceae)	Agricultural: AS, CNMI, FSM, Fi, FP, G, H, K, MI, NC, Ni, P, PNG, S, SI, T, V, WF	Mexico to Peru & Venezuela, & in the West Indies & Bermuda (SI)	Edible: FSM
Sorghum bicolor subsp. drummondii (Poaceae)	Environmental: CNMI, CI, FSM, Fi, FP, G, H, MI, NC, Ni, P, PI, T, WF	Mediterranean region of Europe, & Syria	Edible: CNMI; FSM; Fi; G; H; MI; NC; Ni
Sorghum halepense (Poaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, NC, P, PNG, PI, S, SI, T, V, WF	Tropical & subtropical Eastern Africa	?Not stated: NC; SI

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
No	see above	BP	S	N	?
Rottboellia coelorachis native to V, NC	No	BP	S	Y	?
R. probus (NG); *R moluccanus* (FSM, Fi, NC, NG, SI); *R. rosifolius* (W Pacific including V); 2 native spp (H)	Yes	BP	V	Y	?
see above	Yes	BP	V	Y	?
see above	Yes	BP	S	N	?
see above	Yes	BP	V	Y	?
see above	Yes	BP	V	N	?
see above	Yes	BP	V	N	?
No	No	BP	V	Y	N
S. gaudichaudii is indigenous to Hawai'i & other islands throughout the Pacific.	No	A	S	Y	Y1
S. fallax is native to most of the Pacific Islands, including H	No	BP	S	Y	N
see above	No	BP	S	Y	N
Native throughout Pacific e.g. *S repandum; S. americanum*	Yes	BP	S	N	?
S. laxiflorum & *S. nitidum* (NG)	Yes	A	S	N	?
see above	see above	BP	V	Y	?

Weed species (Family)	Land use (Agricultural, Environmenal or both) and regions affected by weed	Native range of weed	Why & where is the weed cultivated in the region?
Spathodea campanulata (Bignoniaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, S, SI, T, V, WF	West Africa	Ornamental: AS; CI; FSM; Fi; FP; G; H; K; Na; NC; Ni; P; S; SI; T; WF
Sphagneticola trilobata (Asteraceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, S, To, T	Central America	Ornamental: AS; CNMI; CI; FSM; Fi; H; K; MI; Na; NC; Ni; P; T
Stachytarpheta jamaicensis (Verbenaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, T, Tu, V, WF	Tropical & subtropical areas of the New World (SI)	No
Stachytarpheta urticifolia = Cayennensis (Verbenaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, T, Tu, V, WF	Tropical & subtropical areas of the New World	No
Syzygium cumini (Myrtaceae)	Environmental: CI, Fi, FP, G, H, NC, Ni, P, S, T	Indo-Malaysian	Edible: Fi; FP; G; H; NC; Ni
Syzygium (=Waterhousea) floribundum (Myrtaceae)	Environmental: FP	Australia	
Syzygium jambos (Myrtaceae)	Environmental: AS, CI, FSM, Fi, FP, G, H, NC, Ni, P, PI, S, T, WF	Southeast Asia	Edible: AS; FSM; Fi; FP; H; Ni; WF
Tecoma stans (Bignoniaceae)	Both agricultural and environmental: AS, CNMI, CI, FSM, Fi, FP, G, H, K, MI, Na, NC, Ni, P, PNG, S, SI, T, WF	Caribbean & South America	AS; FSM; Fi; FP; G; H; K; MI; Na; NC; Ni; P; SI; T; WF
Vachellia farnesiana = Acacia farnesiana (Fabaceae)	Both agricultural and environmental: CNMI, CI, Fi, FP, G, H, K, Na, NC, P, SI, V	Mexico & Central America	?In H formerly cultivated for an attempted perfume industry: MaI; H; P, SI
Xanthium strumarium (Asteraceae)	Agricultural: CI, Fi, FP, H, NC, PNG	North America	No

Native congener of weed in Pacific region?	Valued exotic congener of weed cultivated in Pacific region?	Lifestyle	Reprod-uction	Weed in native range	Hy
No	No	BP	V	N	?
No	No	BP	V	N	?
No	No	BP	S	N	?
No	No	BP	S	N	?
Genus widespread in Pacific e.g. *S. suborbiculare* (NG); *S. wolfii* (Fi); S. *sandwicensis* (H)	Yes	BP	S	N	?
see above	Yes	BP	S	N	?
see above	Yes	BP	S	N	?
No	Yes *T. capensis* in CI; NC; Ni	BP	S	N	?
No	No	BP	S	Y	?
No	No	A	S	Y	No

Appendix 3

Current status of biocontrol programmes against weed species listed in Appendix 1.

WEED SPECIES	REGIONS AFFECTED BY WEED	STATUS OF BIOCONTROL PROGRAMME(S)	REGIONS BIOCONTROL USED IN PACIFIC
Acacia mearnsii (Fabaceae)	Cook Islands, Hawaii	Programme in South Africa limited to seed-feeders to contain weed, without impacting on beneficial attributes	Not used
Acacia melanoxylon (Fabaceae)	Hawaii, New Caledonia	Programme in South Africa limited to seed-feeders to contain weed, without impacting on beneficial attributes	Not used
Cardiospermum grandiflorum (Sapindaceae)	Cook Islands, French Polynesia, Hawaii	Native range surveys conducted	Not used
Chromolaena odorata (Asteraceae)	Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, Palau, PNG	Biocontrol ongoing & showing signs of success (e.g. in New Guinea), but still required in other regions	Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Palau, PNG
Clerodendrum chinense (Lamiaceae)	American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Hawaii, Niue, PNG, Western Samoa, Tonga	Native range surveys conducted	Not used
Clerodendurm paniculatum (Lamiaceae)	American Samoa, Federated States of Micronesia, Fiji, French Polynesia, Guam, Marshall Islands, Nauru, Palau, PNG, Western Samoa, Solomon Islands	Native range surveys conducted	Not used
Clidemia hirta (Melastomataceae)	American Samoa, Federated States of Micronesia, Fiji, Hawaii, Palau, PNG, Western Samoa, Solomon Islands, Vanuatu, Wallis and Futuna	Good control in pasture, but not in shade: ongoing programme in Hawaii	Fiji, Hawaii
Coccinia grandis (Curcubitaceae)	Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Fiji, Guam, Hawaii, Marshall Islands, PNG, Western Samoa, Solomon Islands, Tonga, Vanatu	Ongoing programme, but promising results in Hawaii	Commonwealth of the Northern Mariana Islands, Guam, Hawaii

WEED SPECIES	REGIONS AFFECTED BY WEED	STATUS OF BIOCONTROL PROGRAMME(S)	REGIONS BIOCONTROL USED IN PACIFIC
Cyperus rotundus (Cyperaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Western Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna	Unsuccessful programme in Hawaii	Hawaii, unsuccessful
Eichhornia crassipes (Pontederiaceae)	American Samoa, Cook Islands, Federate States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Marshall Islands, Nauru, New Caledonia, Palau, PNG, Western Samoa, Vanuatu	Successful programme in Papua New Guinea (still needed elsewhere)	PNG, Fiji, Vanuatu
Hedychium coronarium (Zingiberaceae)	American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Nauru, New Caledonia, Palau, Western Samoa, Tonga, Wallis and Futuna	Native range surveys conducted	Not used
Hedychium flavescens (Zingiberaceae)	American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Hawaii, New Caledonia, Niue, Western Samoa, Tonga	Native range surveys conducted	Not used
Hedychium gardnerianum (Zingiberaceae)	Cook Islands, Fiji, French Polynesia, Hawaii, New Caledonia	Native range surveys conducted	Not used
Lantana camara (Verbenaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Pitcairn Islands, Western Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Wallis and Futuna	Varying success	Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Guam, Hawaii,
Miconia calvescens (Melastomataceae)	French Polynesia, Hawaii, New Caledonia	Biocontrol agent released in French Polynesia, ongoing programme & too early to assess full impact	French Polynesia
Mikania micrantha (Asteraceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Marshall Islands, New Caledonia, Niue, Palau, PNG, Western Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna	Biocontrol agents have been released, but not in Pacific (Liothrips mikaniae failed to establish in the Solomon Islands) ongoing & too early to assess full impact	

WEED SPECIES	REGIONS AFFECTED BY WEED	STATUS OF BIOCONTROL PROGRAMME(S)	REGIONS BIOCONTROL USED IN PACIFIC
Mimosa diplotricha (Fabaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, New Caledonia, Niue, Palau, PNG, Western Samoa, Solomon Islands, Vanuatu, Wallis and Futuna	Successful in many parts of Pacific, still needed French Polynesia, Vanuatu, New Caledonia	Successful in many parts of Pacific
Mimosa pigra (Fabaceae)	PNG	Big impacts measured Australia, but too early to assess full impact	
Parthenium hysterophorus (Asteraceae)	French Polynesia, Hawaii, New Caledonia, Vanuatu	Variable success in Australia: biocontrol effective in central Queensland, less so in North Queensland	
Passiflora tarminiana (includes *P. tripartita & P. mollissima*) (Passifloraceae)	Guam, Hawaii	Yes, partially successful: initial reduction in biomass due to Septoria, but virulence of the pathogen appears to have reduced	Hawaii
Psidium cattleianum (Myrtaceae)	Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Hawaii, New Caledonia, Palau, Pitcairn Islands, Western Samoa	Native range surveys conducted and host-range testing performed	
Rottboellia cochinchinensis (Poaceae)	Fiji, PNG, Solomon Islands	Overseas surveys and host-range testing performed, unclear if any agents have been released	
Rubus argutus (Rosaceae)	Hawaii	Agents only partially effective & have non-target impacts on native Rubus in Hawaii	Hawaii
Salvinia molesta (Salviniaceae)	Fiji, French Polynesia, Hawaii, New Caledonia, PNG, Vanuatu	Yes, successfully controlled in Papua New Guinea, Fiji. Agents not released yet in Hawaii, New Caledonia, Vanuatu	Fiji, PNG
Senna tora (Fabaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, New Caledonia, Niue, PNG, Western Samoa, Solomon Islands, Tonga, Vanuatu, Wallis and Futuna	Native range surveys were done, but no adequately specific agents were found	

WEED SPECIES	REGIONS AFFECTED BY WEED	STATUS OF BIOCONTROL PROGRAMME(S)	REGIONS BIOCONTROL USED IN PACIFIC
Sida acuta (Malvaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Western Samoa, Solomon Islands, Tonga, Vanuatu	Successful control in Australia, Fiji, Vanuatu, Papua New Guinea, but control still required elsewhere	Fiji, PNG, Vanuatu
Sida rhombifolia (Malvaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Pitcairn Islands, Western Samoa, Solomon Islands, Tokelau, Tonga, Vanuatu, Wallis and Futuna	Successful control in Australia, Fiji, Vanuatu, Papua New Guinea, but control still required elsewhere	Fiji, PNG, Vanuatu
Tecoma stans (Bignoniaceae)	American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, PNG, Western Samoa, Solomon Islands, Tonga, Wallis and Futuna	Agents released in South Africa, but too early to assess impact	
Xanthium strumarium (Asteraceae)	Cook Islands, Fiji, French Polynesia, Hawaii, New Caledonia, PNG	Epiblema strenuata & an accidentally introduced fungus (Puccinia xanthii) have had major impact in humid regions of Australia	

Appendix 4

Feasibility scores for the north-west Pacific. Green shading = easier targets; orange shading = intermediate targets; red shading = harder targets.

BIOCONTROL FEASIBILITY SCORE	WEED
100	*Eichhornia crassipes*
100	*Mimosa diplotricha*
100	*Salvinia molesta*
100	*Sida acuta*
100	*Sida rhombifolia*
100	*Xanthium strumarium*
83	*Mimosa pigra*
80	*Chromolaena odorata*
74	*Antigonon leptopus*
74	*Coccinia grandis*
74	*Hedychium coronarium*
74	*Psidium cattleianum*
74	*Spathodea campanulata*
74	*Sphagneticola trilobata*
69	*Costus speciosus*
67	*Commelina benghalensis*
67	*Epipremnum aureum*
67	*Imperata cylindrica*
61	*Adenanthera pavonina*
61	*Albizia lebbeck*
61	*Albizia saman = Samanea saman*
59	*Ardisia elliptica*
59	*Cestrum diurnum*
59	*Cestrum nocturnum*
59	*Clerodendrum chinensis*
59	*Clerodendrum quadriloculare*

BIOCONTROL FEASIBILITY SCORE	WEED
59	*Clidemia hirta*
59	*Lantana camara*
59	*Leucaena leucocephala*
59	*Melinis minutiflora*
59	*Meremia tuberosa*
59	*Mikania micrantha*
59	*Piper auritum*
59	*Psidium guajava*
59	*Stachytarpheta jamaicensis*
59	*Stachytarpheta urticifolia*
59	*Tecoma stans*
57	*Paraserianthes (Albizia) falcataria*
52	*Ischaemum timorense*
52	*Ischaemum polystachyum var. chordatum*
52	*Merremia peltata*
52	*Panicum repens*
52	*Paspalum conjugatum*
52	*Paspalum distichum*
52	*Pennisetum purpureum*
52	*Sorghum halepense*
52	*Vachellia farnesiana*
50	*Kyllingia polyphylla*
50	*Mimosa pudica*
49	*Ageratum conyzoides*
49	*Rottboellia cochinchinensis*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
46	*Syzygium jambos*
45	*Sorghum bicolor subsp. drummondii*
44	*Acacia confusa*

BIOCONTROL FEASIBILITY SCORE	WEED
44	*Clerodendurm paniculatum*
44	*Passiflora tripartata*
44	*Pennisetum setaceum*
44	*Piper aduncum*
42	*Solanum torvum*
39	*Passiflora foetida*
37	*Panicum maximum*
37	*Paspalum urvillei*
36	*Pennisetum polystachion*
35	*Cenchrus echinatus*
35	*Ocimum gratissimum*
34	*Bidens pilosa*
34	*Cuscuta campestris*
34	*Euphorbia hirta*
30	*Senna tora*
20	*Cyperus rotundus*

Appendix 5

Effort Scores for the North-west Pacific (where a low score indicates less effort required to conduct a biocontrol programme).

EFFORT SCORE	WEED
4	*Eichhornia crassipes*
13	*Mimosa diplotricha*
13	*Salvinia molesta*
13	*Xanthium strumarium*
13	*Chromolaena odorata*
13	*Tecoma stans*
15	*Lantana camara*
17	*Hedychium coronarium*
20	*Mimosa pigra*
22	*Mikania micrantha*
23	*Sida acuta*
23	*Sida rhombifolia*
29	*Sphagneticola trilobata*
29	*Stachytarpheta jamaicensis*
31	*Spathodea campanulata*
31	*Costus speciosus*
31	*Stachytarpheta urticifolia*
32	*Psidium cattleianum*
36	*Imperata cylindrica*
36	*Clerodendrum chinensis*
36	*Rottboellia cochinchinensis*
36	*Clerodendurm paniculatum*
38	*Antigonon leptopus*
38	*Coccinia grandis*
38	*Albizia saman = Samanea saman*
38	*Cestrum diurnum*
38	*Cestrum nocturnum*

EFFORT SCORE	WEED
38	*Clidemia hirta*
38	*Leucaena leucocephala*
38	*Vachellia farnesiana*
38	*Mimosa pudica*
38	*Cyperus rotundus*
40	*Commelina benghalensis*
40	*Epipremnum aureum*
40	*Adenanthera pavonina*
40	*Albizia lebbeck*
40	*Ardisia elliptica*
40	*Clerodendrum quadriloculare*
40	*Melinis minutiflora*
40	*Meremia tuberosa*
40	*Paraserianthes (Albizia) falcataria*
40	*Merremia peltata*
40	*Kyllingia polyphylla*
40	*Ageratum conyzoides*
41	*Senna tora*
43	*Sorghum halepense*
43	*Cuscuta campestris*
44	*Psidium guajava*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
46	*Sorghum bicolor subsp. drummondii*
46	*Passiflora tripartata*
46	*Passiflora foetida*
47	*Euphorbia hirta*
48	*Piper auritum*
48	*Panicum repens*
48	*Pennisetum setaceum*
48	*Solanum torvum*

EFFORT SCORE	WEED
48	*Cenchrus echinatus*
50	*Ischaemum timorense)*
50	*Ischaemum polystachyum var. chordatum*
50	*Paspalum conjugatum*
50	*Paspalum distichum*
50	*Pennisetum purpureum*
50	*Syzygium jambos*
50	*Acacia confusa*
50	*Piper aduncum*
50	*Panicum maximum*
50	*Paspalum urvillei*
50	*Pennisetum polystachion*
50	*Ocimum gratissimum*
50	*Bidens pilosa*

Appendix 6

The top 20 targets for North-west Pacific region, based on both feasibility and effort where Total score (= Feasibility score × 1/Effort score). Green shading = easier targets; orange shading = intermediate targets. *Weeds for which biocontrol agents are already established in the region. Information regarding where biocontrol is required is extracted from Dodd and Hayes (2009).

TOTAL SCORE	WEED	RANK	WHERE IN REGION IS BIOCONTROL REQUIRED?
25.000	*Eichhornia crassipes**	1	
7.692	*Mimosa diplotricha**	2=	
7.692	*Salvinia molesta**	2=	
7.692	*Xanthium strumarium*	2=	Papua New Guinea
6.154	*Chromolaena odorata**	5	
4.538	*Tecoma stans*	6	
4.353	*Hedychium coronarium*	7	Papua New Guinea
4.348	*Sida acuta**	8=	Guam; Federated States of Micronesia; Solomon Islands
4.348	*Sida rhombifolia**	8=	Commonwealth of the Northern Mariana Islands; Guam; Solomon Islands
4.150	*Mimosa pigra**	10	Papua New Guinea
3.933	*Lantana camara**	11	
2.682	*Mikania micrantha*	12	Palau; Commonwealth of the Northern Mariana Islands; Federated States of Micronesia; Guam
2.552	*Sphagneticola trilobata*	13	Federated States of Micronesia; Solomon Islands, Papua New Guinea
2.387	*Spathodea campanulata*	14	Federated States of Micronesia; Solomon Islands
2.313	*Psidium cattleianum*	15	
2.226	*Costus speciosus*	16	Palau; Federated States of Micronesia
2.034	*Stachytarpheta jamaicensis*	17	Commonwealth of the Northern Mariana Islands; Federated States of Micronesia; Guam; Solomon Islands, Papua New Guinea
1.947	*Antigonon leptopus*	18=	Palau; Commonwealth of the Northern Mariana Islands; Federated States of Micronesia; Guam
1.947	*Coccinia grandis**	18=	Solomon Islands, Papua New Guinea
1.903	*Stachytarpheta urticifolia*	20	Commonwealth of the Northern Mariana Islands; Federated States of Micronesia; Guam; Solomon Islands, Papua New Guinea

Appendix 7

Feasibility scores for the central Pacific. Green shading = easier targets; orange shading = intermediate targets; red shading = harder targets.

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
100	*Eichhornia crassipes*
100	*Mimosa diplotricha*
100	*Salvinia molesta*
100	*Sida acuta*
100	*Sida rhombifolia*
100	*Xanthium strumarium*
74	*Antigonon leptopus*
74	*Coccinia grandis*
74	*Hedychium coronarium*
74	*Hedychium flavescens*
74	*Hedychium gardnerianum*
74	*Psidium cattleianum*
74	*Spathodea campanulata*
74	*Sphagneticola trilobata*
69	*Costus speciosus*
67	*Commelina benghalensis*
67	*Epipremnum aureum*
67	*Imperata cylindrica*
63	*Broussonnetia papyrifera*
61	*Adenanthera pavonina*
61	*Albizia lebbeck*
61	*Albizia saman = Samanea saman*
61	*Rubus rosifolius*
60	*Parthenium hysterophorus*
59	*Albizia chinensis*
59	*Ardisia elliptica*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
59	*Cestrum diurnum*
59	*Cestrum nocturnum*
59	*Clerodendrum chinensis*
59	*Clerodendrum quadriloculare*
59	*Clidemia hirta*
59	*Lantana camara*
59	*Leucaena leucocephala*
59	*Melinis minutiflora*
59	*Meremia tuberosa*
59	*Miconia calvescens*
59	*Mikania micrantha*
59	*Piper auritum*
59	*Psidium guajava*
59	*Stachytarpheta jamaicensis*
59	*Stachytarpheta urticifolia*
59	*Tecoma stans*
57	*Paraserianthes (Albizia) falcataria*
54	*Rubus moluccanus*
52	*Vachellia farnesiana*
52	*Cecropia peltata*
52	*Ischaemum polystachyum var. chordatum*
52	*Merremia peltata*
52	*Paspalum conjugatum*
52	*Paspalum distichum*
52	*Pennisetum clandestinum*
52	*Pennisetum purpureum*
52	*Sorghum halepense*
50	*Kyllingia polyphylla*
50	*Mimosa pudica*
49	*Ageratum conyzoides*
46	*Passiflora laurifolia*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
46	*Syzygium jambos*
45	*Sorghum bicolor subsp. drummondii*
44	*Acacia melanoxylon*
44	*Acacia spirobis*
44	*Clerodendrum japonicum*
44	*Clerodendurm paniculatum*
44	*Pennisetum setaceum*
44	*Piper aduncum*
42	*Solanum torvum*
39	*Passiflora foetida*
37	*Panicum maximum*
37	*Paspalum urvillei*
36	*Pennisetum polystachion*
35	*Cenchrus echinatus*
35	*Ocimum gratissimum*
34	*Bidens pilosa*
34	*Euphorbia hirta*
34	*Rottboellia cochinchinensis*
34	*Cuscuta campestris*
30	*Senna tora*
20	*Cyperus rotundus*

Appendix 8

Effort scores for the central Pacific (where a low score indicates less effort required to conduct a biocontrol programme).

EFFORT SCORE	WEED SPECIES
4	*Eichhornia crassipes*
13	*Mimosa diplotricha*
13	*Salvinia molesta*
23	*Sida acuta*
23	*Sida rhombifolia*
13	*Xanthium strumarium*
38	*Antigonon leptopus*
38	*Coccinia grandis*
17	*Hedychium coronarium*
17	*Hedychium flavescens*
17	*Hedychium gardnerianum*
32	*Psidium cattleianum*
31	*Spathodea campanulata*
29	*Sphagneticola trilobata*
31	*Costus speciosus*
40	*Commelina benghalensis*
40	*Epipremnum aureum*
36	*Imperata cylindrica*
40	*Broussonnetia papyrifera*
40	*Adenanthera pavonina*
40	*Albizia lebbeck*
38	*Albizia saman = Samanea saman*
47	*Rubus rosifolius*
13	*Parthenium hysterophorus*
40	*Albizia chinensis*
40	*Ardisia elliptica*

EFFORT SCORE	WEED SPECIES
38	*Cestrum diurnum*
38	*Cestrum nocturnum*
36	*Clerodendrum chinensis*
40	*Clerodendrum quadriloculare*
38	*Clidemia hirta*
15	*Lantana camara*
38	*Leucaena leucocephala*
40	*Melinis minutiflora*
40	*Meremia tuberosa*
22	*Miconia calvescens*
22	*Mikania micrantha*
48	*Piper auritum*
44	*Psidium guajava*
29	*Stachytarpheta jamaicensis*
31	*Stachytarpheta urticifolia*
13	*Tecoma stans*
40	*Paraserianthes (Albizia) falcataria*
50	*Rubus moluccanus*
38	*Vachellia farnesiana*
40	*Cecropia peltata*
50	*Ischaemum polystachyum var. chordatum*
40	*Merremia peltata*
50	*Paspalum conjugatum*
50	*Paspalum distichum*
50	*Pennisetum clandestinum*
50	*Pennisetum purpureum*
43	*Sorghum halepense*
40	*Kyllingia polyphylla*
38	*Mimosa pudica*
40	*Ageratum conyzoides*
46	*Passiflora laurifolia*

EFFORT SCORE	WEED SPECIES
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
50	*Syzygium jambos*
46	*Sorghum bicolor subsp. drummondii*
31	*Acacia melanoxylon*
47	*Acacia spirobis*
40	*Clerodendrum japonicum*
36	*Clerodendurm paniculatum*
48	*Pennisetum setaceum*
50	*Piper aduncum*
48	*Solanum torvum*
46	*Passiflora foetida*
50	*Panicum maximum*
50	*Paspalum urvillei*
50	*Pennisetum polystachion*
48	*Cenchrus echinatus*
50	*Ocimum gratissimum*
50	*Bidens pilosa*
47	*Euphorbia hirta*
36	*Rottboellia cochinchinensis*
43	*Cuscuta campestris*
41	*Senna tora*
38	*Cyperus rotundus*

Appendix 9

The top 20 targets for the central Pacific region, based on both feasibility and effort where Total score (= Feasibility score × 1/Effort score). Green shading = easier targets; orange shading = intermediate targets. *Weeds for which biocontrol agents are already established in the region. Information regarding where biocontrol is required is extracted from Dodd and Hayes (2009).

TOTAL SCORE	WEED SPECIES	RANK	WHERE IS BIOCONTROL NEEDED IN REGION?
25.000	*Eichhornia crassipes*	1	New Caledonia; Samoa
7.692	*Mimosa diplotricha**	2=	New Caledonia; Vanuatu
7.692	*Salvinia molesta**	2=	New Caledonia
7.692	*Xanthium strumarium*	2=	Fiji
4.615	*Parthenium hysterophorus*	5	
4.538	*Tecoma stans*	6	
4.353	*Hedychium coronarium*	7=	Niue; Fiji
4.353	*Hedychium flavescens*	7=	Niue; Fiji
4.353	*Hedychium gardnerianum*	7=	Niue; Fiji
4.348	*Sida acuta**	10=	Niue; Samoa
4.348	*Sida rhombifolia**	10=	New Caledonia; Samoa
3.933	*Lantana camara**	12	Samoa
2.682	*Miconia calvescens*	13=	
2.682	*Mikania micrantha*	13=	New Caledonia
2.552	*Sphagneticola trilobata*	15	Fiji; Vanuatu
2.387	*Spathodea campanulata*	16	Niue; Samoa; Tonga; Vanuatu
2.313	*Psidium cattleianum*	17	
2.226	*Costus speciosus*	18	
2.034	*Stachytarpheta jamaicensis*	19	Fiji; New Caledonia; Niue; Samoa; Tonga; Vanuatu
1.947	*Antigonon leptopus*	20=	Niue; Samoa
1.947	*Coccinia grandis*	20=	Fiji; Samoa; Vanuatu

Appendix 10

Feasibility scores for Hawaii. Green shading = easier targets; orange shading = intermediate targets; red shading = harder targets.

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
100	*Eichhornia crassipes*
100	*Salvinia molesta*
100	*Sida acuta*
100	*Sida rhombifolia*
100	*Xanthium strumarium*
74	*Antigonon leptopus*
74	*Clerodendrum chinensis*
74	*Clerodendrum quadriloculare*
74	*Coccinia grandis*
74	*Hedychium coronarium*
74	*Hedychium flavescens*
74	*Hedychium gardnerianum*
74	*Melinis minutiflora*
74	*Meremia tuberosa*
74	*Piper auritum*
74	*Psidium cattleianum*
74	*Spathodea campanulata*
74	*Sphagneticola trilobata*
69	*Costus speciosus*
67	*Commelina benghalensis*
67	*Epipremnum aureum*
67	*Sorghum halepense*
63	*Broussonetia papyrifera*
61	*Adenanthera pavonina*
61	*Albizia lebbeck*
61	*Albizia saman = Samanea saman*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
61	*Rubus niveus*
61	*Rubus rosifolius*
60	*Sorghum bicolor subsp. drummondii*
59	*Albizia chinensis*
59	*Ardisia elliptica*
59	*Cecropia obtusifolia*
59	*Cestrum diurnum*
59	*Cestrum nocturnum*
59	*Clerodendrum japonicum*
59	*Clidemia hirta*
59	*Lantana camara*
59	*Leucaena leucocephala*
59	*Miconia calvescens*
59	*Piper aduncum*
59	*Psidium guajava*
59	*Stachytarpheta jamaicensis*
59	*Stachytarpheta urticifolia*
59	*Tecoma stans*
57	*Cardiospermum grandiflorum*
57	*Paraserianthes (Albizia) falcataria*
54	*Rubus ellipticus*
52	*Vachellia farnesiana*
52	*Panicum repens*
52	*Paspalum conjugatum*
52	*Paspalum distichum*
52	*Pennisetum clandestinum*
52	*Pennisetum purpureum*
51	*Rubus argutus*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
50	*Cyperus rotundus*
50	*Mimosa pudica*
49	*Ageratum conyzoides*
46	*Passiflora laurifolia*
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Rubus glaucus*
46	*Syzygium cumini*
46	*Syzygium jambos*
44	*Acacia confusa*
44	*Acacia mearnsii*
44	*Acacia melanoxylon*
44	*Passiflora tripartata*
44	*Pennisetum setaceum*
42	*Solanum torvum*
39	*Passiflora foetida*
37	*Panicum maximum*
37	*Paspalum urvillei*
36	*Pennisetum polystachion*
35	*Cenchrus echinatus*
35	*Ocimum gratissimum*
34	*Bidens pilosa*
34	*Euphorbia hirta*
34	*Cuscuta campestris*
0	*Cassytha filiformis*

Appendix 11

Effort scores for Hawaii (where a low score indicates less effort required to conduct a biocontrol programme).

EFFORT SCORE	WEED SPECIES
4	*Eichhornia crassipes*
13	*Salvinia molesta*
13	*Xanthium strumarium*
13	*Tecoma stans*
15	*Lantana camara*
17	*Hedychium coronarium*
17	*Hedychium flavescens*
17	*Hedychium gardnerianum*
21	*Cardiospermum grandiflorum*
22	*Miconia calvescens*
23	*Sida acuta*
23	*Sida rhombifolia*
24	*Rubus argutus*
29	*Sphagneticola trilobata*
29	*Stachytarpheta jamaicensis*
31	*Spathodea campanulata*
31	*Costus speciosus*
31	*Stachytarpheta urticifolia*
31	*Acacia mearnsii*
31	*Acacia melanoxylon*
32	*Psidium cattleianum*
36	*Clerodendrum chinensis*
38	*Antigonon leptopus*
38	*Coccinia grandis*
38	*Albizia saman = Samanea saman*
38	*Cestrum diurnum*
38	*Cestrum nocturnum*

EFFORT SCORE	WEED SPECIES
38	*Clidemia hirta*
38	*Leucaena leucocephala*
38	*Vachellia farnesiana*
38	*Cyperus rotundus*
38	*Mimosa pudica*
40	*Clerodendrum quadriloculare*
40	*Melinis minutiflora*
40	*Meremia tuberosa*
40	*Commelina benghalensis*
40	*Epipremnum aureum*
40	*Broussonetia papyrifera*
40	*Adenanthera pavonina*
40	*Albizia lebbeck*
40	*Albizia chinensis*
40	*Ardisia elliptica*
40	*Cecropia obtusifolia*
40	*Clerodendrum japonicum*
40	*Paraserianthes (Albizia) falcataria*
40	*Ageratum conyzoides*
43	*Sorghum halepense*
43	*Cuscuta campestris*
44	*Psidium guajava*
46	*Sorghum bicolor subsp. drummondii*
46	*Passiflora laurifolia*
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
46	*Passiflora tripartata*
46	*Passiflora foetida*
47	*Rubus niveus*
47	*Rubus rosifolius*

EFFORT SCORE	WEED SPECIES
47	*Euphorbia hirta*
48	*Piper auritum*
48	*Panicum repens*
48	*Rubus glaucus*
48	*Pennisetum setaceum*
48	*Solanum torvum*
48	*Cenchrus echinatus*
50	*Piper aduncum*
50	*Rubus ellipticus*
50	*Paspalum conjugatum*
50	*Paspalum distichum*
50	*Pennisetum clandestinum*
50	*Pennisetum purpureum*
50	*Syzygium jambos*
50	*Acacia confusa*
50	*Panicum maximum*
50	*Paspalum urvillei*
50	*Pennisetum polystachion*
50	*Ocimum gratissimum*
50	*Bidens pilosa*

Appendix 12

The top 20 targets for Hawaii, based on both feasibility and effort where Total score (= Feasibility score × 1/Effort score). Green shading = easier targets; orange shading = intermediate targets. *Weeds for which biocontrol agents are already established in the region. Information regarding where biocontrol is required is extracted from Dodd and Hayes (2009).

TOTAL SCORE	WEED SPECIES	RANK	IS BIOCONTROL NEEDED IN HAWAII?
25.000	*Eichhornia crassipes*	1	No
7.692	*Salvinia molesta*	2=	Yes
7.692	*Xanthium strumarium*	2=	No
4.538	*Tecoma stans*	4	No
4.353	*Hedychium coronarium*	5=	Yes
4.353	*Hedychium flavescens*	5=	Yes
4.353	*Hedychium gardnerianum*	5=	Yes
4.348	*Sida acuta*	8=	No
4.348	*Sida rhombifolia*	8=	No
3.933	*Lantana camara**	10	No?
2.714	*Cardiospermum grandiflorum*	11	No
2.682	*Miconia calvescens*	12	Yes
2.552	*Sphagneticola trilobata*	13	No
2.387	*Spathodea campanulata*	14	Yes
2.313	*Psidium cattleianum*	15	Yes
2.226	*Costus speciosus*	16	No
2.125	*Rubus argutus**	17	No
2.056	*Clerodendrum chinensis*	18	No
2.034	*Stachytarpheta jamaicensis*	19	No
1.947	*Antigonon leptopus*	20=	No
1.947	*Coccinia grandis**	20=	Yes

Appendix 13

Feasibility scores for the south-east Pacific. Green shading = easier targets; orange shading = intermediate targets; red shading = harder targets.

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
100	*Eichhornia crassipes*
100	*Mimosa diplotricha*
100	*Salvinia molesta*
100	*Sida acuta*
100	*Sida rhombifolia*
100	*Xanthium strumarium*
74	*Antigonon leptopus*
74	*Clerodendrum chinensis*
74	*Clerodendrum quadriloculare*
74	*Hedychium coronarium*
74	*Hedychium flavescens*
74	*Hedychium gardnerianum*
74	*Melinis minutiflora*
74	*Meremia tuberosa*
74	*Mikania micrantha*
74	*Spathodea campanulata*
74	*Sphagneticola trilobata*
69	*Costus speciosus*
67	*Epipremnum aureum*
67	*Merremia peltata*
67	*Sorghum halepense*
65	*Kyllingia polyphylla*
61	*Adenanthera pavonina*
61	*Albizia lebbeck*
61	*Albizia saman = Samanea saman*
61	*Rubus rosifolius*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
60	*Lantana camara*
60	*Parthenium hysterophorus*
60	*Sorghum bicolor subsp. drummondii*
59	*Albizia chinensis*
59	*Ardisia elliptica*
59	*Cecropia obtusifolia*
59	*Cestrum diurnum*
59	*Cestrum nocturnum*
59	*Clerodendurm paniculatum*
59	*Leucaena leucocephala*
59	*Miconia calvescens*
59	*Psidium cattleianum*
59	*Stachytarpheta jamaicensis*
59	*Stachytarpheta urticifolia*
59	*Tecoma stans*
57	*Cardiospermum grandiflorum*
57	*Paraserianthes (Albizia) falcataria*
52	*Vachellia farnesiana*
52	*Cecropia peltata*
52	*Panicum repens*
52	*Paspalum conjugatum*
52	*Paspalum distichum*
52	*Pennisetum purpureum*
50	*Cenchrus echinatus*
50	*Mimosa pudica*
49	*Ageratum conyzoides*
46	*Passiflora laurifolia*
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Passiflora rubra*
46	*Syzygium cumini*

BIOCONTROL FEASIBILITY SCORE	WEED SPECIES
46	*Syzygium floribundum*
46	*Syzygium jambos*
44	*Acacia mearnsii*
44	*Acacia spirobis*
44	*Psidium guajava*
42	*Solanum torvum*
39	*Passiflora foetida*
37	*Panicum maximum*
37	*Paspalum urvillei*
36	*Pennisetum polystachion*
35	*Ocimum gratissimum*
34	*Bidens pilosa*
34	*Euphorbia hirta*
34	*Cuscuta campestris*
30	*Senna tora*
20	*Cyperus rotundus*

Appendix 14

Effort scores for the south-east Pacific (where a low score indicates less effort required to conduct a biocontrol programme).

EFFORT SCORE	WEED SPECIES
4	*Eichhornia crassipes*
13	*Mimosa diplotricha*
13	*Salvinia molesta*
13	*Xanthium strumarium*
13	*Parthenium hysterophorus*
13	*Tecoma stans*
15	*Lantana camara*
17	*Hedychium coronarium*
17	*Hedychium flavescens*
17	*Hedychium gardnerianum*
21	*Cardiospermum grandiflorum*
22	*Mikania micrantha*
22	*Miconia calvescens*
23	*Sida acuta*
23	*Sida rhombifolia*
29	*Sphagneticola trilobata*
29	*Stachytarpheta jamaicensis*
31	*Spathodea campanulata*
31	*Costus speciosus*
31	*Stachytarpheta urticifolia*
31	*Acacia mearnsii*
32	*Psidium cattleianum*
36	*Clerodendrum chinensis*
36	*Clerodendurm paniculatum*
38	*Antigonon leptopus*
38	*Albizia saman = Samanea saman*
38	*Cestrum diurnum*

EFFORT SCORE	WEED SPECIES
38	*Cestrum nocturnum*
38	*Leucaena leucocephala*
38	*Vachellia farnesiana*
38	*Mimosa pudica*
38	*Cyperus rotundus*
40	*Clerodendrum quadriloculare*
40	*Melinis minutiflora*
40	*Meremia tuberosa*
40	*Epipremnum aureum*
40	*Merremia peltata*
40	*Kyllingia polyphylla*
40	*Adenanthera pavonina*
40	*Albizia lebbeck*
40	*Albizia chinensis*
40	*Ardisia elliptica*
40	*Cecropia obtusifolia*
40	*Paraserianthes (Albizia) falcataria*
40	*Cecropia peltata*
40	*Ageratum conyzoides*
41	*Senna tora*
43	*Sorghum halepense*
43	*Syzygium floribundum*
43	*Cuscuta campestris*
44	*Psidium guajava*
46	*Sorghum bicolor subsp. drummondii*
46	*Passiflora laurifolia*
46	*Passiflora ligularis*
46	*Passiflora quadrangularis*
46	*Syzygium cumini*
46	*Passiflora foetida*
47	*Rubus rosifolius*
47	*Acacia spirobis*

EFFORT SCORE	WEED SPECIES
47	*Euphorbia hirta*
48	*Panicum repens*
48	*Cenchrus echinatus*
48	*Solanum torvum*
50	*Paspalum conjugatum*
50	*Paspalum distichum*
50	*Pennisetum purpureum*
50	*Passiflora rubra*
50	*Syzygium jambos*
50	*Panicum maximum*
50	*Paspalum urvillei*
50	*Pennisetum polystachion*
50	*Ocimum gratissimum*
50	*Bidens pilosa*

Appendix 15

The top 20 targets for the south-east Pacific region, based on both feasibility and effort where Total score (= Feasibility score × 1/Effort score). Green shading = easier targets; orange shading = intermediate targets. *Weeds for which biocontrol agents are already established in the region. Information regarding where biocontrol is required is extracted from Dodd and Hayes (2009). **Biocontrol programme underway (Dodd & Hayes 2009).

TOTAL SCORE	WEED SPECIES	RANK	WHERE IN REGION IS BIOCONTROL REQUIRED?
25.000	*Eichhornia crassipes*	1	
7.692	*Mimosa diplotricha*	2=	Cook Islands**; French Polynesia
7.692	*Salvinia molesta*	2=	
7.692	*Xanthium strumarium*	2=	
4.615	*Parthenium hysterophorus*	5	
4.538	*Tecoma stans*	6	
4.353	*Hedychium coronarium*	7=	
4.353	*Hedychium flavescens*	7=	
4.353	*Hedychium gardnerianum*	7=	
4.348	*Sida acuta*	8=	
4.348	*Sida rhombifolia*	8=	French Polynesia
4.000	*Lantana camara*	12	Cook Islands**
3.364	*Mikania micrantha*	13	
2.714	*Cardiospermum grandiflorum*	14	
2.682	*Miconia calvescens**	15	French Polynesia**
2.552	*Sphagneticola trilobata*	16	
2.387	*Spathodea campanulata*	17	Cook Islands; French Polynesia
2.226	*Costus speciosus*	18	
2.056	*Clerodendrum chinensis*	19	French Polynesia
2.034	*Stachytarpheta jamaicensis*	20	

Appendix 16

Factors influencing weed "importance".

Considerable resources are required if a biological control project is to be completed well (Fowler 2000) and so it is critical that weeds selected for management by this technique justify the investment. Whether biological control is the best response to a weed problem depends not only on the likelihood of achieving sufficient control to overcome weediness (likelihood of success), but also on the ecological and/or environmental importance of the weed (the potential benefits of its control). Hiebert (1997) has described the ecological, economic and managerial rationales for the prioritisation of weeds. He advocated the development of score-based decision-making tools to rank weeds on the basis of present level of impacts, future threat, and the feasibility and cost of conventional control. Systems of varying complexity exist for assessing the relative risk (and hence the economic and environmental importance) of invasive plant species in New Zealand (Owen 1997; Pheloung et al. 1999; Williams & Newfield 2002; Williams et al. 2005) Australia (Thorp & Lynch 2000), Canada and USA.

In Australia, the Weeds of National Significance (WoNS) have been identified by an objective scoring system to identify those invasive plants that have nationally significant economic and ecological impacts (Thorp & Lynch 2000). More recently the National Post-Border Weed Risk Management (WRM) Protocol (Anon. 2006) was formulated to further develop a risk-based decision support system for prioritising weed species management at the regional, state/territory, and national levels. This Protocol provides a generic guide to the development of a post-border WRM decision framework, including the key criteria that should be considered in assessing and comparing weed risks posed by different plant species and the feasibility of managing these species through coordinated control.

This Protocol relates to decision support systems for determining:

- Species for inclusion in (or removal from) noxious weed lists
- Priorities for eradication or containment programs
- Priorities for prevention of and early intervention against new weed incursions
- Plant species with existing or potential commercial uses which pose a weed risk and require active management to limit their spread from plantings
- Priorities for investment into research and extension leading to improved weed management (e.g. biocontrol priorities)

This Protocol is an adaptation of the approaches and content of the two Australia/New Zealand Standards:

- AS/NZS 4360:2004, Risk Management; and
- HB 203-2006, Environmental risk management-Principles and process

(http://www.fao.org/ag/AGP/agpp/IPM/Weeds/doc/FAOprocedure for post-border weed risk m.pdf).

Other approaches to the assessment of weed importance exist. Robertson et al. (2003) proposed a scoring system for South African weeds that allows prioritisation of weed risk according to potential invasiveness, distribution and density, potential environmental, economic and social impacts, potential weed impacts, potential for control, and conflicts of interest (the system did not examine the feasibility of biological control in any depth). They noted that it was desirable for a range of assessors to score each weed to limit bias. They introduced a separate 'confidence score' so that assessors could indicate the reliability of data associated with each attribute, or the absence of such information. The overall confidence score then informed the reliability of the criterion scores.

Most national schemes for setting priorities for weed management are based on the current or future economic or environmental impact of the weed (e.g. Moran et al. 2005). Weed risk assessment systems may not adequately distinguish the relative importance of abundant weeds that are a problem currently and those that are of limited distribution but high potential. Nel et al. (2004) concluded that value of scoring systems is limited if there is no objective threshold at which a weed qualifies for management action, and the comparison of weed species with different suites of important attributes is difficult. They devised a system to 'cluster' weed species into those with established distributions and levels of current impact (major invaders) and those with high potential for invasion and impact (emerging invaders). Biological control against plants in an early stage of invasion has not been widely practised. However, the principle of formally recognizing and funding research on biological control of emerging weeds was established in South Africa in 2003 when the Working for Water program decided to support studies on five species of incipient weeds (Olckers 2004). Similarly, Groenteman et al. (2008) introduced the concept of multi-targeting: selecting agents that could simultaneously affect major weeds and related, less abundant plants with potential to become weeds in the future.

References

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CEPF Small Grant Final Project Completion Report

Recent initiatives to develop biocontrol for the Pacific: strategy workshop and weed prioritisation exercise

Organization Legal Name

Landcare Research New Zealand Ltd

Project Title

Recent initiatives to develop biocontrol for the Pacific: strategy workshop and weed prioritisation exercise

Date of Report

1 September 2010

Report Author and Contact Information

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CEPF Region

Polynesia-Micronesia Hotspot

Strategic Direction

1. Prevent, control and eradicate invasive species in key biodiversity areas.

Grant Amount

US$15,000

Project Dates

Workshop was held 16–18 of November 2009. Additional report arising from the workshop on prioritising weed targets for biocontrol was produced between 1/3/10 and 31/7/10.

Implementation Partners for this Project

Please explain the level of involvement for each partner

Workshop

Secretariat for the Pacific Community (SPC). Contact: Warea Orapa. Workshop organizing committee, responsible for workshop proceedings, and on steering group set up to make activities suggested at the workshop happen.

United States Forest Service (USFS). Contacts: Anne Marie La Rosa and Tracy Johnson. Workshop organizing committee. Tracy is on steering group set up to make activities suggested at the workshop happen.

Pacific Invasives Learning Network (PILN). Contact: Mark Bonin. Workshop organizing committee, and on steering group set up to make activities suggested at the workshop happen.

Secretariat of the Pacific Regional Environment Programme (SPREP). Contact Alan Tye. Workshop organizing committee, and on steering group set up to make activities suggested at the workshop happen. Was not able to attend actual workshop.

Landcare Research New Zealand Ltd. Contacts: Lynley Hayes and Sarah Dodd. Workshop organizing committee. Quentin Paynter is on steering group set up to make activities suggested at the workshop happen.

Pacific Invasives Initiative. Contact: Souad Boudjelas. Workshop organizing committee, and on steering group set up to make activities suggested at the workshop happen.

Other members of the steering group include: Wilco Liebregts (PestNet), Christian Mille (French territories), Billy Enosa (Polynesia), Tony-George Gunua (Melanesia), Konrad Englberger (Micronesia), Dick Shaw (CABI), Darcy Oishi (Hawai'i), and Mic Julien (Australia).

Prioritisation Exercise

The USDA Forest Service contributed US$12,000 to enable this project to proceed. Anne Marie La Rosa (USDA Forest Service, Hawaii), Mic Julien (CSIRO, Australia), Jean-Yves Meyer (Ministère de la Mer, la Pêche, L'Aquaculture et la Recherche, French Polynesia) and Konrad Engleberger (formerly SPC, Federated States of Micronesia) assisted by reviewing information used in this report.

Conservation Impacts

Please explain/describe how your project has contributed to the implementation of the CEPF ecosystem profile

The project aimed to address the following strategic directions (highlighted below).

1. Prevent, control and eradicate invasive species in key biodiversity areas.

   1.1 Strengthen defences against the introduction and spread of invasive species and pathogens that threaten biodiversity

   1.2 Control or eradicate invasive species in key biodiversity areas, particularly where they threaten native species with extinction.

   1.3 Perform research, provide training in management techniques, and develop rapid response capacity against particularly serious invasive species.

A workshop was held at the Waipuna Hotel and Conference Centre,Auckland, New Zealand, on 16–18 November 2009. There were 47 participants, representing 17 countries and territories (American Samoa, Australia, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, Guam, Hawai'i, New Caledonia, New Zealand, Palau, Papua New Guinea, Samoa, Tonga and Vanuatu, United States of America, and the United Kingdom). Also there were organisations representing the Pacific Region (Pacific Invasives Learning Network (PILN), Secretariat of the Pacific Community (SPC), the Pacific Invasives Initiative (PII), and the University of the South Pacific (USP). This workshop brought together key players together to see whether biocontrol of widespread invasive species could be undertaken on a more co-operative and collaborative basis in the Pacific, and to develop a regional strategic plan that would allow this to happen. The workshop:

- Reviewed biocontrol activities and programs undertaken previously or currently underway in the Pacific. Agreed that biocontrol projects undertaken to date in the Pacific have demonstrated that biocontrol is a highly successful and relatively inexpensive tool for controlling pests and diseases in the Pacific.
- Agreed that the amount of biocontrol activity should be increased in the Pacific, as this is the only feasible way of dealing with many pests. Identified opportunities and actions to increase biocontrol work in the Pacific e.g. listed many well-known, highly effective biocontrol agents available in the Pacific that could be shared much more widely at low cost right now.
- Agreed that biocontrol needs to be developed for many more species. Discussed criteria for selecting priority species for biocontrol. Prepared a list of species that should be targeted for biocontrol (should be considered a working list that is reviewed regularly). Identified some key projects for development that will be submitted to funders within the next 12 months (including a project to prioritise the 90 species suggested for biocontrol). Identified potential funding sources for biocontrol projects.
- Identified capacity gaps and barriers to using biocontrol to manage invasive species. Also identified where additional spare capacity could be sourced.
- Identified actions and mechanisms for increasing the understanding and acceptance of the use of biocontrol as a management tool in the Pacific. Concluded an independent advisory group should be set up that could review biocontrol agent release applications and provide independent advice to governments. Agreed on a need to increase communication both within the biocontrol community and externally with all stakeholders, and came up with ways of doing this.
- Created a steering group to assist in the implementation of the regional strategic plan developed at the workshop.

For further details see the full workshop report:

Dodd S, Hayes L 2009. *Pacific biocontrol strategy workshop 2009 report*. Landcare Research Contract Report LC0910/069, Landcare Research, Auckland, New Zealand.

Since not all the funds that were made available to hold the workshop were needed for this purpose, we got permission from CEPF to use the remaining funds to undertake a prioritization of weed targets for biocontrol exercise. A framework developed for Australia by Paynter et al. (2009) was used to identify the most promising targets for weed biocontrol in the Pacific. A report on the outcomes (Paynter 2010) has been produced and will be circulated to all workshop participants and other interested parties.

Paynter Q, Hill R, Bellgard S, Dawson M 2009. *Improving targeting of weed biological control projects in Australia*. Landcare Research Contract Report LC0809/072, Landcare Research, Auckland, New Zealand.

Paynter Q 2010. *Prioritisation of targets for biological control of weeds in the Pacific region*. Landcare Research Contract Report LC0910/190, Landcare Research, Auckland, New Zealand.

Please summarize the overall results/impact of your project against the expected results detailed in the approved proposal

Workshop

1) Review and raise awareness of biological control activity in the Pacific to date. Done. SPC intends to produce a proceedings of the papers and posters presented. These are currently available on line at www.issg.org/cii/BioControlWorkshop.html
2) Develop a strategy for increasing the use of biocontrol as a means to manage widespread invasive species in the Pacific Islands. This will include identifying potential funding sources, developing a prioritized list of invasive species on which to focus in the next decade, detailing available resources infrastructure and capacity, outlining barriers to the increased use of biocontrol and possible solutions to these, plus an action plan. A report on this will be produced. Done, report produced.
3) Set up a committee comprised of representatives from a range of organisations and countries to progress this strategy and follow on tasks. PII, SPC, and SPREP are expected to play a major role in driving the strategy and implementing it. Done, see implementation partners above.
4) Set up a network of interested people for further communication. Done, workshop report circulated to 34 people that did not attend. List of these names also passed on to steering group.

Prioritisation Exercise

The Pacific was divided up into four regions with similar floras and weed problems and a prioritization exercise was undertaken for each region:

1. North-west: including New Guinea, Micronesia & the Solomon Islands
2. Central: including New Caledonia, Vanuatu, Fiji, Tuvalu, Samoa, American Samoa & Tonga
3. North-east: Hawaii
4. South-east: Cook Islands, French Polynesia & Pitcairn Islands.

Information was found for most of the relevant attributes for all the weed species, enabling feasibility of biocontrol, effort and overall scores (based on both the feasibility and effort required to implement biocontrol) to be calculated, as expected, for all weed species. Ideally, weeds should also be prioritised on the basis of importance, so the relative importance of the 96 weeds in each region still need to be determined by individual countries, before final rankings can be achieved. Likewise individual countries need to assess and factor in the seriousness of any potential conflicts of interest (for example, where a weed has some perceived beneficial attributes that might preclude the use of biocontrol).

Even though more work will need to be done by individual countries to refine the scores and therefore rankings for their weeds, this initial cut has still provided much useful information. It has indicated where there is considerable scope for redistribution of existing, proven biocontrol agents for some of the worst weeds in the Pacific region (*Chromolaena odorata, Eichhornia crassipes, Lantana camara, Mimosa diplotricha, Mimosa pigra, Parthenium hysterophorus, Salvinia molesta, Sida acuta, Sida rhombifolia,* and *Xanthium strumarium*). Also it predicts that a number of current weed targets

for biocontrol where agents have not yet been released or where it is too early to evaluate the impact of biocontrol, will be good targets (*Coccinia grandis, Hedychium spp.* and *Psidium cattleianum*) or intermediate targets (*Miconia calvescens, Mikania micrantha, Tecoma stans*). This exercise has also identified a number of weeds that are serious problems in the Pacific but have never been targeted for biocontrol as good targets for biocontrol (*Antigonon leptopus, Clerodendrum chinensis, Spathodea campanulata,* and *Sphagneticola trilobata*) while others were consistently identified as difficult targets (*Bidens pilosa, Cyperus rotundus, Mimosa pudica, Passiflora spp.,* and *Senna tora/obtusifolia*).

Weeds that do not fall in the top 20 should still be considered for biocontrol if they are of importance to countries, as projects against more difficult targets can still succeed, but they just might require more resources. An integrated, pragmatic decision-making process should be used alongside the framework, to decide on a portfolio of weed targets that includes a range of good, medium and hard weed biocontrol targets

Please provide the following information where relevant

- *Hectares Protected*: N/A
- *Species Conserved*: N/A
- *Corridors Created*: N/A

Describe the success or challenges of the project toward achieving its short-term and long-term impact objectives

Workshop

The workshop was very successful in achieving its objectives. It was very challenging for the organizing committee to organise such a workshop, owing to the logistics involved in such an exercise. Securing the necessary funding was difficult, as was working within the constraints/conditions imposed by each of the organizations that provided funds.

Prioritisation Exercise

It was difficult to get input from a wide-range of botanists familiar with the flora of the Pacific. However it was possible to make a good first cut at identifying the best targets with further refinements possible.

Were there any unexpected impacts (positive or negative)?

Workshop

Local Maori (tangata whenua) when approached to assist with a welcome ceremony became very interested in the workshop and funded some of their own delegates to attend.

Lessons Learned

Describe any lessons learned during the design and implementation of the project, as well as any related to organizational development and capacity building. Consider lessons that would inform projects designed or implemented by your organization or others, as well as lessons that might be considered by the global conservation community.

Project Design Process: (aspects of the project design that contributed to its success/ shortcomings)

Workshop

Having a multi-agency organising committee created challenges (e.g. organizing teleconferences to discuss workshop arrangements with people in different time zones) but allowed access to a wider range of skills and networks. Having a wide Pacific representation at the workshop allowed for excellent information-sharing, networking and problem solving.

Prioritisation Exercise

It would have been easier to get more input from Pacific botanists if the time frames for this project had not been so tight.

Project Implementation: (aspects of the project execution that contributed to its success/ shortcomings)

Workshop

It was essential to have a good workshop organiser, to assist with the workshop logistics, and to have strong and effective facilitation in order to achieve the workshop's aims. This was money well spent.

Prioritisation Exercise

Information provided by the Pacific Island Ecosystems at Risk (PIER) website (http://www.hear.org/pier/) was particularly useful. However, information regarding the current legal status (for example, whether cultivation is banned) of weeds in the Pacific region was difficult to find.

Other lessons learned relevant to conservation community:

Workshop

It was disappointing that some participants left securing travel visas until the last minute which meant one person was unable to travel, and several others nearly missed out. I would recommend that organizing committees who are paying for participants' travel do not purchase air tickets until participants provide proof that they have a valid visa. It was also disappointing that some people decided not to come after tickets had been purchased, for various reasons. I would recommend that organizing committees, who are paying for participants' travel, make it a condition that participants' employers sign an agreement that they will reimburse the organizing committee for any travel booked that is not refundable if their employees are no-longer able to travel owing to a change in work commitments.

Additional Funding

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Donor	Type of funding*	Amount	Notes
NZAid	A	NZ$20,000	Workshop
US Forest Service	A	US$33,590	Workshop
US State Dept	A	US$26,000	Workshop
Hawaii Invasive Species Council	A	US$8,000	Workshop
Landcare Research	A	NZ$3,000	Workshop
USDA Forest Service	A	US$12,000	Prioritisation Exercise

**Additional funding should be reported using the following categories:*

A Project co-financing (Other donors contribute to the direct costs of this CEPF project)

B Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)

C Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)

Sustainability/Replicability

Summarize the success or challenge in achieving planned sustainability or replicability of project components or results.

Summarize any unplanned sustainability or replicability achieved.

Workshop

It was easy to find people that were prepared to be on a steering group (to make actions agreed to at the workshop happen afterwards) and to obtain representation from key groups that need to be involved e.g. SPC, PILN, SPREP, PII. However, how well this group is able to operate and keep up the momentum required remains to be seen.

Prioritisation Exercise

The challenge for the future will be to update information to enhance certainty regarding the rankings and to develop a prioritisation process that includes the importance of the weeds as well as their amenability to biological control.

Safeguard Policy Assessment

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

N/A

Performance Tracking Report Addendum

Provide a numerical amount and brief description of the results achieved by your grant. Please respond to only those questions that are relevant to your project.

PROJECT RESULTS	Is this question relevant?	*Numerical response for results achieved during the annual period.*	*Numerical response for project from inception of CEPF support to date.*	*Principal results achieved from 1 February 2009–31 January 2010.*
1. *Did your project strengthen management of a protected area guided by a sustainable management plan? Please indicate number of hectares improved.*	N/A			
2. *How many hectares of new and/or expanded protected areas did your project help establish through a legal declaration or community agreement?*	N/A			
3. *Did your project strengthen biodiversity conservation and/or natural resources management inside a key biodiversity area identified in the CEPF ecosystem profile? If so, please indicate how many hectares.*	N/A			
4. *Did your project effectively introduce or strengthen biodiversity conservation in management practices outside protected areas? If so, please indicate how many hectares.*	N/A			
5. *If your project promotes the sustainable use of natural resources, how many local communities accrued tangible socioeconomic benefits?*	N/A			

Additional Comments/Recommendations

This was a thoroughly worthwhile workshop – thanks for your support in allowing it to happen and for permission to use unspent funds on the prioritization exercise.

Information Sharing and CEPF Policy

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned, and results. Final project completion reports are made available on our website, www.cepf.net, and publicized in our newsletter and other communications.

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List of Key Acronyms

ACIAR	Australian Centre for International Agricultural Research
APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
AUSAID	Australian Aid Fund
BC	Biological control
BCA	Biological control agent
CABI	Commonwealth Agricultural Bureau International
CEPF	Critical Ecosystem Partnership Fund
CNMI	Commonwealth of the Northern Mariana Islands
CRGA	Communities of Representatives of Governments and Administrations of the Pacific Communities
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
CTA	The Technical Centre for Agricultural and Rural Cooperation – Le Centre technique de coopération agricole et rurale
DPI	Department of Primary Industries
EPA	Environmental Protection Agency (USA)
EU	European Union
FSM	Federated States of Micronesia
GEF	Global Environment Fund
GISAC	Graduate Inter-School Activities Council (USA)
HDOA	Hawai'i Department of Agriculture
HEAR	Hawai'i Ecosystems at Risk
ID	Identification
IOBC	International Organisation for Biological Control
IPM	Integrated Pest Management
MAF	Ministry of Agriculture and Fisheries
NARI	National Agriculture Research Institute
NC	New Caledonia
NGO	Non Government Organisation
NIFA	National Institute of Food and Agriculture (USA)
NSF	National Science Foundation (USA)
NZAID	New Zealand Aid Fund
NZD	New Zealand dollars
PEQ	Post Entry Quarantine
PestNet	Email network for the Pacific and South East Asia to obtain rapid advice and information on plant protection, including quarantine (www.pestnet.org)
PII	Pacific Invasives Initiative
PILN	Pacific Invasives Learning Network
PNG	Papua New Guinea
PPPO	Pacific Plant Protection Organisations
RISC	Regional Invasive Species Council
RMI	Republic of Marshall Islands
RP	Republic of the Philippines
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Program
TNC	The Nature Conservancy
UOG	University of Guam
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USP	University of the South Pacific
USSD	United States State Department

CONSERVATION INTERNATIONAL

Pacific Islands

BIODIVERSITY CONSERVATION LESSONS LEARNED TECHNICAL SERIES

5