The need to build biological control capacity in the Pacific

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Summary

Whilst clearing of native vegetation and unsustainable harvesting pose serious threats to the Pacific Islands, invasive species are considered to pose the biggest threat to the remaining biodiversity. The Pacific weed problem is huge – whole forests are smothered by vines, suppressing the birds and bats that rely on forest resources and which in turn disperse the forest species, as well as causing problems for agriculture and in subsistence gardens. All 22 Pacific island countries and territories face major weed problems, ranging from their impacts on simple island ecosystems and on Islanders’ ways of life, to the logistics of tackling the problems, including access and capacity issues, and resource, information and technique limitations. The capacity of individual Pacific countries and territories to tackle weeds is very limited, in terms of people with skills, and technology, policy and infrastructure. Pacific countries and territories therefore work collectively through intergovernmental agencies such as the South Pacific Regional Environment Programme (SPREP) and the Secretariat of the Pacific Community (SPC) to address common issues with the help of key donors and partners. The Pacific has developed a Regional Invasive Species Strategy and many countries are developing national strategies and cross-sectoral committees. Pacific weed efforts are focusing on identifying what weeds are present in each country, noting other species that may be invasive if introduced, strengthening country capacity to prevent their establishment, and building capacity of each country and their people to better address the problems. There are a few successful examples of control – including biocontrol – and eradication that lend us heart. The Pacific Island countries and territories need effective collaboration with partners who have developed or could develop weed control techniques that work safely in the tropical conditions of the Pacific, such as biological control. This needs to be supported by gathering necessary information and developing or modifying appropriate techniques, plus the expertise to safely apply them.

Keywords: biocontrol, biodiversity, biological control, capacity, invasive species, Pacific, partners, weeds.

Introduction

The Pacific Islands region consists of thousands of mostly tiny islands and atolls – only seven have land areas of over 700 km² – in an ocean of 33 million km² (Power 2003) – less than 2% land.

Pacific biodiversity is globally significant. Species on islands are predisposed to genetic drift and natural selection towards endemism because of their relative isolation and reduced opportunities for mixing with continental populations. The number of species groups present declines eastwards as distance from Asia and Australia increases. Opportunities for new arrivals to radiate into unfilled niches can lead to unusual habitat selections, often in the absence of the larger predators of the continents. For example, lizards living in tidal zones, ground-nesting birds and land-dwelling crabs all occur in island situations. Populations of species restricted to one or a few islands are therefore often very small and thus especially vulnerable to any catastrophic event, whether natural, such as cyclones or volcanic eruptions, or otherwise, such as the wide range of impacts that people can inadvertently cause. The rate of extinction of native species has been higher on islands than anywhere else in the world.
In global analyses of conservation importance, the Pacific ranks highly, despite its minimal land area. The island of New Guinea is considered one of the biologically most diverse parts of the world (Mittermeier and Mittermeier 1997) and the Micronesia–Polynesian region is considered one of the most biologically rich and threatened regions of the world (Mittermeier et al. 2000). Many more species are endangered in the region than would be expected on the basis of its land area. The Pacific harbours a quarter of the world’s globally threatened birds (Hilton-Taylor 2000) of which more than half are restricted to their islands or the region (Stuttersfield et al. 2000). Many plant and animal groups remain incompletely studied so it is likely that figures for biodiversity and endemism for this region will continue to rise. The living connection between biodiversity and people in the Pacific provides an additional social and cultural layer to be considered in addressing conservation needs in the region. The Pacific Islands are home to a great number of indigenous cultural groups, who have retained their robust cultural traditions, over a thousand distinct languages, and strong traditional attachments to the land, sea and natural resources.

**Invasives: the biggest threat to biodiversity**

Pacific island countries and territories are particularly vulnerable to the effects of invasive species such as weeds – island species are far more prone to extinction than continental species. A regional invasive species review (Sherley 2000) concluded that invasive species pose the greatest threat to remaining biodiversity of the Pacific. On a global scale, after clearing and habitat loss, invasive species are responsible for more species extinctions than any other cause. The Convention on Biological Diversity (CBD) under Article 8(h) recognizes the importance of this global problem and has called on contracting Parties to “prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats and species”. Many of the Pacific Island countries are signatories to the Convention but lack the capacity to implement the required measures to protect their countries.

Island ecosystems have been totally changed by the introduction of a wide variety of species – of pigs, cattle, and goats for food, of cats and dogs for company, of mongooses and mynas for control of other pests such as rats or cattle ticks, and by accidentally introduced pests, such as various rats, ants and snails. Many of these species have become part of more complex ecological interactions, and have led to interspecies “chain reactions” of problems (Sherley 2000).

Invasive plants – or weeds – also have dramatic impacts, causing a wide range of ecological changes that significantly degrade native ecosystems. Whole forests are smothered by vines, suppressing in turn the native flora and the fauna that depend on the forest products and that in turn disperse the tree seeds to replenish the forest. In addition to the permanent extermination of endemic species, impacts on the native vegetation can include: reduction in diversity and abundance of native species, including other native species that in turn depend on them; less complex vegetation structure (fewer vertical layers of plants available, so fewer niches available for other species); competition for light; and displacement of native species by more vigorous cosmopolitan species. In addition to the direct threats on biodiversity, invasive weeds cause changes to essential ecosystem processes such as soil and water quantity and quality, water retention and nutrient cycling that also affect them (Sherley 2000).

However, the most obvious impacts of invasive weeds are those to the economic, agricultural, health, social and cultural sectors. The impacts on ecosystems listed above affect people as well as native species, as does the loss or reduction in the ability of native species to continue to provide other benefits such as providing traditional medicines, firewood, building materials and food sources. In addition, some invasive weeds impact on human and domestic-animal health.

Prevention is the most cost-effective response, followed by rapid response to incursions and eradication where feasible, but several weed species are already well established, widespread and causing harm to a country.

**Pacific weed challenge and response**

The existing Pacific weed problem is huge – all 22 Pacific island countries and territories face major weed problems, ranging from the various impacts they have on native island ecosystems and on islanders’ ways of life, to the scale of the logistics necessary to tackle the problems. Hundreds of invasive and agricultural weed species have been recorded from Pacific Island countries and territories (Swarbrick 1997, Pacific Island Ecosystems at Risk Project, see <http://www.hear.org/pier>). Weed species known to occur in each country have been recorded, as well as highlighting species likely to become invasive should they be imported to the country either deliberately or accidentally.

Pacific Islanders live so close to the land that their very livelihoods and lifestyles are impacted when an invasive species causes problems. As an example, the introduction of taro-leaf blight disease, caused by
**Regional collaboration**

Fortunately, however, the Pacific island countries and territories work collectively through various intergovernmental regional agencies to address the issues they hold in common and to ensure their voice is heard in world forums. The South Pacific Regional Environment Programme (SPREP), the agency responsible for supporting the members to tackle their environmental issues, and the Secretariat of the Pacific Community (SPC), responsible for assisting with their agriculture and health issues, are the key intergovernmental agencies that work with the countries and territories to address invasive species and weed issues with the help of key donors and partners through the Invasive Species Programme of SPREP and the Plant Protection Service of SPC. There are encouraging signs of efforts to improve collaboration between regional organizations to address the threats of invasive weeds. The focus is on both managing existing weeds as well as preventing the spread of risk species between the islands, thus helping countries fulfill their obligations under the Convention of Biodiversity.

A result of this collective work include a Regional Invasive Species Strategy, collectively developed and endorsed by the SPREP member countries (Sherley 2000), focusing on means to address invasive species affecting terrestrial biodiversity. A wider sectoral representation (including regional and national agricultural officers) at a regional meeting hosted by the Global Invasive Species Program in 2002 agreed that the strategy was equally applicable to marine, freshwater and agricultural sectors as well and recommended that the strategy be revisited to reflect these wider sectoral interests and to encourage inter-sectoral collaboration.

At the country level, many members are developing national invasive species strategies and cross-sectoral approaches to the issue. Current Pacific invasive weed efforts are focusing on identifying weeds present in each country, noting other species that may be invasive if introduced, strengthening country capacity to prevent their establishment and building the capacity of each country and their people to better address the problems.

Most existing weed management efforts are associated with, and limited to, agricultural production areas only and usually rely heavily on the use of herbicides, rather than addressing a specific weed problem from a multi-sectoral and ecological perspective. Since 1951, SPC’s Plant Protection Service has been involved in addressing most of the past and present regional pest and disease problems, in collaboration with national partners, focusing on species of agricultural and health concern, but including many species known to be invasive. Emphasis by SPC is placed on prevention of weed introductions (by supporting national quarantine capabilities), preparation (improving capacity to address new weed, pests and disease cases) and management of well-established problem species. An Invasive Species Programme was established at SPREP in 1998 to focus more on plant, animal or microbe species of particular biodiversity concern, and works closely with SPC on species of mutual concern.

There is an increasing number of examples of weed eradication and management in the Pacific, with emphasis on biological control of specific environmental weeds, such as eradication of *Sphagenticola trilobata* and *Mimosa diplostricha* in Niue, eradication of some populations of *Mikania micrantha* in Palau (Joel Miles, pers. comm.), an eradication project on *Falcataria moluccana* in American Samoa’s National Park (Tavita Togia, pers. comm.), and biological control of *Chromolaena odorata* in Guam, Palau, Federated States of Micronesia (Bamba 2002) and Papua New Guinea (PNG) (Orapa et al. 2002). Successful past cases of biological control in the Pacific include the efforts against water hyacinth (*Eichhornia crassipes*) in PNG (Julien and Orapa 1999, 2001), the successful control of *Salvinia molesta* in the Sepik River in PNG which resulted in immense socioeconomic benefits for thousands of villagers and the restoration of natural ecology to its original stage (Thomas and Room 1986) and to some extent the partial suppression of *Lantana camara* in the Pacific Islands (W.O., personal observation).
**Priority Pacific weeds and biocontrol**

Several key weed species are too big and widespread to tackle by hand or by chemicals. Many weeds are alien species introduced intentionally or unintentionally since humans first arrived in the Pacific, most arriving without their guild of natural enemies or diseases that would otherwise keep their numbers under control. Many of these weeds are therefore good targets for biological control programs.

There has been longstanding interest in the use of biocontrol in the Pacific. Seminal work for the region was undertaken by Waterhouse (1993, 1997, Waterhouse *et al.* 1998) and, in 1995, a Pacific Biocontrol workshop was held and one of the outcomes was the development of guidelines for conduct of biological control in the Pacific.

Successful biological control of several weeds has already occurred in some Pacific island countries where safe and effective agents have been released (Waterhouse & Norris 1987, Room 1993, Julien & Griffiths 1998, Julien & Orapa 1999, 2001). However, much past biological control work against weeds in the region has been done on an ad-hoc basis – future regional biological control programs need to be developed, structured and implemented following set guidelines that minimize the chance of releasing species that can in turn become pests on non-target species. It is only when inappropriately tested agents are considered that problems can arise.

No cases of a weed biocontrol agent adversely affecting non-target species are known from the Pacific and the suspected extinction of the coconut moth *Levuana iridescens* of Fiji by the tachinid fly *Bessa remota*, introduced from Malaya in 1925, remains the only documented case of a biological control agent exterminating its (pest) host anywhere in the world (Kuris 2003). However, there have been unfortunate cases of biocontrol agents leading to the extinction of non-target native partulid land-snail species in the Pacific (Cowie 1992), so great care to ensure specificity of biological control agents is extremely important. Regardless, there are no known cases of weed biocontrol agents producing unexpected deleterious impacts and, unless inadequately screened for host preferences, biological control will remain the principal and preferred tool for managing major invasive weeds in the Pacific islands.

Attempts have been made to develop prioritized lists of agricultural weeds for the region, starting with Waterhouse (1997). During the 2002 Regional Technical Meeting on Plant Protection (RTMPP) in Nadi, Fiji, the region’s 45 most important weeds were identified and ranked according to importance (Anon. 2000). Most weeds of significance for agriculture are also key ecological threats. Some of the most serious weeds for the region, as identified by the countries, include nutsedge (*Cyperus rotundus*), the vines mile-a-minute (*Mikania micrantha*) and *Merremia peltata*, the two sensitive weeds *Mimosa diplotricha* and *M. pudica*, lantana (*Lantana camara*), wedelia (*Sphagneticola triloba*), water hyacinth (*Eichhornia crassipes*) and African tulip (*Spathodea campanulata*). Some of these weeds are already a major problem in many or most countries, impacting upon both agriculture and the environment, but little has been done to control them. The top 24 of these species are listed in Table 1, together with an indication of the level of significance of their impact and suggested potential for biocontrol. It can be noted that this list does not include some tree species that may only be of considerable concern to the environment rather than to agriculture, such as the albizzias *Albizia chinensis* and *Falcataria moluccana*.

Of the prioritized weed list (Anon. 2000), the majority (69%) have no known biological control agents available. For the rest, 18% have had at least one natural enemy released in or outside the Pacific region with no follow-up work or evaluation in the region, while 13% of weeds listed by the RTMPP have good biological control agents already available in some Pacific island countries or outside the region which could be assessed for use in the affected countries. There is an urgent need to conduct new research into new possible biological control agents and to re-visit previously released but forgotten biological control agents for the management of some of the region’s most serious weeds.

Few or no original biological control research and development programs against weeds have been attempted in the Pacific region because of the large initial costs and length of time that may be involved. The only attempt at initiating biological control in the region was the preliminary exploration for natural enemies of Honolulu rose (*Clerodendron chinensis*) in Vietnam and southern China, but this did not proceed to the next step. Not all SPC and SPREP member countries and territories have the capacity to run separate biocontrol projects. Only a few (Fiji, PNG, Guam, and New Caledonia) have undertaken biological control programs and have some capacity to undertake biological control against weeds and pest problems.

Development and customization of Pacific-appropriate control measures, such as new biocontrol agents, is an important task for the Pacific. The use of biocontrol is highly suited to countries with limited technical capacity to maintain sustained control programs using other techniques, although it must be undertaken using best practice standards to ensure that the chosen agent will not become a new pest in its own right.

The Pacific island countries and territories need strong technical and resourcing partners who have developed or could develop techniques that work safely in the tropical conditions of the Pacific. We need help to learn from other successful control projects. We need partners who can help by gathering the needed information and developing or modifying appropriate techniques. We also need help to successfully and safely apply them.
### Table 1. The top 24 potential candidate weeds for biological control in Pacific island countries and territories (PICTs).

<table>
<thead>
<tr>
<th>Weed name</th>
<th>Number of PICTs identifying the species as a key invasive species/weed in 2002&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Regional agricultural weed ranking in 1997&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Possible biological control response (BCA = biological control agent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Key pest</td>
<td>Important pest</td>
<td>No. of countries ranking in their top 10</td>
</tr>
<tr>
<td>Mikania micrantha</td>
<td>11</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Cyperus rotundus</td>
<td>10</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Merremia peltata</td>
<td>10</td>
<td>10</td>
<td>23&lt;sup&gt;=&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mimosa diploricha (= <em>M. invisa</em>)</td>
<td>8</td>
<td>9</td>
<td>2</td>
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<tr>
<td>Mimosa pudica</td>
<td>7</td>
<td>7</td>
<td>5</td>
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<tr>
<td>Lantana camara</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sphagnetica trilobata</td>
<td>5</td>
<td>5</td>
<td>21&lt;sup&gt;=&lt;/sup&gt;</td>
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<tr>
<td>Bidens pilosa</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Eichhornia crassipes</td>
<td>4</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Spathodea campanulata</td>
<td>4</td>
<td>2</td>
<td>5</td>
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<tr>
<td>Antigonon leptopus</td>
<td>4</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Chromolaena odorata</td>
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<td>4</td>
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<td>Cassia tora</td>
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<td>2</td>
</tr>
<tr>
<td>Stachytarpha urticifolia</td>
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<td>3</td>
<td>20</td>
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<tr>
<td>Sida acuta</td>
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<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Kyllinga polypylla</td>
<td>2</td>
<td>2</td>
<td>26&lt;sup&gt;=&lt;/sup&gt;</td>
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<tr>
<td>Clidemia hirta</td>
<td>2</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Clerodendrum chinense</td>
<td>2</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Sida rhombifolia</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Solanum torvum</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Clerodendrum paniculatum</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>Costus speciosus</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Microm clavescens</td>
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<td>0</td>
<td>28&lt;sup&gt;=&lt;/sup&gt;</td>
</tr>
<tr>
<td>Merremia tuberosa</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
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<sup>a</sup> Derived from assessments made at the 2002 Regional Technical Meeting on Plant Protection, Fiji.

<sup>b</sup> Derived from Waterhouse (1977, p. 78, Table 15).
SPREP and SPC and the Pacific countries and territories are actively seeking to build new partnerships for projects to address invasive species, one specifically on biocontrol development. Objectives of the latter proposal are to reduce the impact of major weeds on agriculture, communities and the environment in member countries and territories by suppressing weed populations to levels below the ecological/economic thresholds, both by using known classical biological control agents as well as seeking to develop new or little known biological control agents of major regional weeds.

The Pacific needs help with this task, which is expensive and technically complex. Components of the project for which assistance would be welcomed include:

- collection and redistribution of suitable biological control agents (BCAs) already released on the target species in some Pacific island countries or territories (or nearby countries) to those countries and territories needing control of a target weed, ensuring that appropriate specificity requirements are met. A regional or subregional rearing facility may be needed to carry out this important activity and the next
- revisit and conduct research into the possibility of using potential weed BCAs that have been released only once in the past and forgotten
- exploration for new potential biological control agents for very important weeds requiring urgent suppression;
- testing of weed-management strategies suitable for Pacific island farming systems and natural area management systems.

The potential impact of this work, if developed and implemented properly, would be seen across all sectors in the Pacific island countries and territories. Production loss due to weeds should decline, there should be a contribution to improvement of the livelihoods of Pacific Islanders and the impact of invasive weeds on the ecosystems on which all Islanders depend would be reduced. The level of threat facing the region’s globally significant and threatened biodiversity would also be reduced, especially if species that cause widespread habitat degradation were better controlled.

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References


