



Economic Impact of Invasive Species in the Pacific



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Executive Summary

Invasive species are a key threat to terrestrial biodiversity and the livelihoods of Pacific Island communities. The impacts of invasive species include direct effects on subsistence and commercial agriculture and forestry and infrastructure, as well as the indirect and intangible effects on underlying ecosystem services and functions and the cultural practices of communities. Such impacts are, and will, be further exacerbated with climate change.

The management of invasive species comes at a cost – costs of eradicating or controlling invasive species, as well as costs of prevention and spread. However, the management of invasive species could also provide localized benefits in the form of poverty relief through the creation of jobs and greater food security.

Understanding the costs of invasive species as well as the costs of management, can assist societies to make more informed decisions, such as: is it ‘worth’ controlling an invasive species, and if so, what is the appropriate level of resources to invest in the prevention, eradication or control, of the invasive species. Demonstrating the economic cost of invasives species is also articulated in the Secretariat of the Pacific Regional Environment Programme (SPREP) and Secretariat of the Pacific Community (SPC) Guidelines for Invasive Species Management in the Pacific (2009).¹

This report represents the finding from Phase 1 of our work assessing the economic impact of invasives species. It identifies what knowledge exists on the economic impact of invasive species and the level of awareness and capacity to undertake such an assessment. We chose to focus on one country, Fiji, rather than broaden the focus to other Pacific Islands to ensure we were able to focus greater resources and potential capacity building in one country. Having said that, our initial scoping review was broader than Fiji or the Pacific Islands so has a broader applicability to other areas.

This phase involved a mix of desktop research and an in-country visit. A desktop review was undertaken for published information available on those invasive species identified for further investigation. The in-country visit had a number of goals. First, to gather feedback from Fijian experts on the species we had initially selected for further review and to refine the species list. Second, to gather additional information collected by various organizations that is not readily available to the public. Third, to gain an understanding of the capacity in Fijian organisations and regional NGOs to undertake an economic assessment of an invasive species. Last, to gain a better understanding of the type of economic impact information the relevant government agencies and NGOs would like to have.

Our initial review confirmed that the capacity to undertake an economic assessment of invasive species was limited and there was little information available to assess the true extent and impact of invasives species at a local/community or national level. We did

¹ These guidelines were developed by the Pacific countries with the assistance of Council of Regional Organisations in the Pacific (CROP) and other development partners.

identify some information sources, though, that could be used as the basis of an economic assessment. One example we explored further as part of this phase was the use of data collected as part of the Biosecurity Fiji response to the Asian subterranean termite (*Coptotermes gestroi*). We are assisting a University of South Pacific student use this information to do a preliminary assessment of the economic cost of the termite, and we hope to further use the data in Phase 2 to estimate future potential costs.

To address these capacity needs we make the following recommendations:

1) Professional training:

Conduct in-country training to build basic skills of government agency staff and the NGO sector for undertaking economic assessments of invasive species.

2) Invasive species assessment tools:

Most toolkits and guidance documents on how to undertake an economic assessment are frequently written in a way that is challenging for non-experts to use. Supplementing these with detailed step-by-step advice on how each step was applied to a real case study and how to identify relevant information sources would greatly enhance their usability.

3) Community Assessments:

Little information exists on the extent, nature and degree of impacts for many invasive species in Fiji. To overcome this data deficiency community-based surveys of invasive species should be conducted. These surveys should be conducted by Fijian-based personnel to develop the in-country capacity to undertake this type of exercise in the future.

4) Routine economic assessment:

To assist with improving the efficiency of government agency responses to prevention, eradication or control or NGO decisions around eradication campaigns routine economic assessments should be encouraged.

5) Increasing the visibility of invasive species

One challenge with the prevention, eradication or control of invasive species is public awareness of invasive species. Targeted education campaigns should be a component of any invasive species management effort.

1 Introduction

The vulnerability of the Polynesia-Micronesia Hotspot to invasive species is well recognised by conservationists globally, although management of invasive species is not given sufficient priority in the region. An analysis of data on the globally threatened species in the hotspot indicates that invasive species are one of the two most serious threats to Pacific biodiversity (Polynesia-Micronesia Biodiversity Hotspot Ecosystem Profile); the other is habitat loss.

Pacific communities rely heavily on natural environmental resources for their economic and social well being, which are being negatively affected by invasive species. The impacts of invasive species include the direct effects on subsistence and commercial agriculture and forestry, and infrastructure. In addition to these direct effects, there are also indirect and intangible effects on the underlying ecosystem services and functions, and cultural practices within communities. Many of these impacts are expected to be further exacerbated by climate change.

Invasive species can be dealt with – by managing and controlling the spread of the invasive species, eradicating the species and reducing the risks of entry for new species – and this comes at a cost. Similarly, there are costs related to the direct negative impacts of invasive species (e.g., production losses) and from indirect impacts (e.g., cultural knowledge is lost when children don't work in village gardens because of ants with painful bites, thereby losing gardening knowledge with potential food security implications).

The corollary of the economic costs of invasive species is the economic benefits of preventing entry and managing invasive species. The management of invasive species may provide localized benefits in the form of poverty relief through the creation of jobs or greater food security.

Understanding the costs of invasive species as well as the costs of management, can assist societies to make more informed decisions about the management of invasive species, such as: is it 'worth' preventing, controlling or eradicating invasive species, and if so, what is the appropriate level of resources to invest in the prevention, control, eradication of the invasive species.

The Secretariat of the Pacific Regional Environment Programme (SPREP) and Secretariat of the Pacific Community (SPC) Guidelines for Invasive Species Management in the Pacific (2009) recognise the need to understand and demonstrate the economic costs of invasive species where objectives around economic costs are articulated (see Box 1).

Project goal

The overall goal of this project, *Economic impact of invasive species in the Pacific (Phases 1 and 2)*, is to help increase investment in the management of invasive species by preparing advocacy material supported by an empirical assessment of the economic costs and benefits of a selection of key invasive species, and building capability for future economic assessments.

This report represents the findings from Phase 1 of this work. It is the initial scoping on what knowledge exists on the economic impact of invasive species and the level of awareness and capacity in Fiji to undertake such an assessment. We chose to focus on one country, Fiji, at this stage rather than broaden the report to other Pacific Islands to ensure we were able to focus greater resources and potential capacity building in one country. Having said that, our initial scoping review was broader than Fiji or the Pacific Islands, and looking more closely at Fiji also allows us to tease out issues that would be relevant across the region. A description of phase 2 of the project is outlined in Section 9.

Box1. Economic cost objectives in the Guidelines for Invasive Species Management in the Pacific

Objective A1.2: Ensure national support by mainstreaming invasive species issues with national and regional decision-makers.

Specific objectives:

A1.2.a Demonstrate the potential economic costs of specific potentially invasive species in the region and the necessity of adequately financing effective biosecurity and rapid-response plans.

A1.2.b: Demonstrate the economic costs of existing invasive species problems in the regional and the economic benefits of financing action to manage them.

A1.2.c: Publicise successes in invasive species prevention and management, including cost/benefit analyses.

Source: SPREP/SPC (2009).

Project Approach

This phase involved a mix of desk-top research and an in-country visit. The desktop review consisted of the review of published information on economics of invasives species identified for further investigation. The review started with what was known about the biology of those invasives species, their establishment and spread in Fiji, their spread to other Pacific Islands, and finally what was known at a global level about the behaviour of those species (the global level review was particularly relevant for those species where little assessment has been done in the Pacific).

The in-country visit had a number of goals. First, it was to gather feedback from Fijian experts on the species we had initially selected for further review and refine the species list. Second, it was to gather additional information that had been collected by various organizations but was not necessarily readily available to the public. Third, it was to gain an understanding of the capacity level within Fijian organisations and regional NGOs for undertaking an economic assessment of an invasive species. Last, it was to gain a better

understanding of the type of economic impact information the relevant agencies and NGOs would like to have and the availability of appropriate types of data for undertaking economic assessment.

2 Invasive Species Targeted

An initial list of invasive species was selected for which more in-depth data was gathered. This list was compiled in-house and covered both floral and faunal species. The list was then circulated to a number of invasive species experts in New Zealand and the Pacific Islands² for further refinement. This initial list consisted of:

- Giant African snail (*Achatina fulica*) – mollusc
- Common myna (*Acridotheres tristis*) – bird
- Yellow crazy ant (*Anoplolepis gracilipes*) – insect
- Coral vine (*Antigonon leptopus*) – vine, climber
- Brown tree snake (*Boiga irregularis*) – reptile
- Coconut leaf beetle (*Brontispa longissima*) – insect
- Ivy gourd (*Coccinia grandis*) – vine, climber
- Green iguana (*Iguana iguana*) – reptile
- Miconia (*Miconia calvescens*) – tree
- Mile-a-minute weed (*Mikania micrantha*) – vine, climber
- Singapore ant (*Monomorium destructor*) – insect
- Strawberry guava (*Psidium cattleianum*) – tree, shrub
- Pacific rat (*Rattus exulans*) – mammal
- Norway rat (*Rattus norvegicus*) – mammal
- Black rat (*Rattus rattus*) – mammal
- Cane toad (*Bufo marinus* (formerly *Rhinella marina*)) – amphibian
- African tulip tree (*Spathodea campanulata*) – tree
- Wedelia (*Sphagneticola* (*Wedelia*) *trilobata*) – herb
- Pig (*Sus scrofa*) – mammal
- Yellow trumpetbush (*Tecoma stans*) – tree, shrub
- Tilapia (*Tilapia zillii*) – fish
- Little fire ant (*Wasmannia auropunctata*) – insect

We took the species list to a number of Fiji government agencies, NGOs and academics to gather their impressions. During this process a number of species were removed as it was believed the Fijian government or local communities would not be interested in eradicating those pests because they were important food sources (e.g., pigs and tilapia). Others were added as they were believed to have more important current impacts or pose risks to Fiji.

² Alan Tye (SPREP), Posa Skelton (PILN), Steve Cranwell (BirdLife), Jean-Yves Meyer (Department of Environment, French Polynesia), Marika Tuiwawa (USP) and Souad Boudelais (PII).

The final list (Table 1) was predominantly species already in Fiji. However, some were not believed to be in Fiji but, should they become introduced and become established, would have significant social, cultural or economic impacts. It is these species that will form the basis of the proposed phase 2 of this work. During the second phase it is proposed to undertake community surveys to determine the prevalence of the invasive species, the perception of damage being caused, and actions (if any) being undertaken to prevent/eradicate/control the species.

Table 1 Top 10 invasive species identified for further assessment, their presence or absence in Fiji, and the range of impacts recorded

Rank	Species	Present in Fiji	Categories of known impact
1	Asian subterranean termite (<i>Coptotermes gestroi</i>)	Y	Agriculture, natural and planted forests, infrastructure
2	Green iguana (<i>Iguana iguana</i>)	Y	Agriculture, tourism
3	African tulip tree (<i>Spathodea campanulata</i>)	Y	Agriculture
4	Mongoose (<i>Herpestes javanicus</i>)	Y	Biodiversity
5	Merremia vine (<i>Merremia peltata</i>)	Y	Agriculture, tourism, biodiversity, cultural values
6	Giant African snail (<i>Achatina fulica</i>)	Y	Health, biodiversity, agriculture
7	Pawana taro beetle (<i>Papuana uninodis</i>)	Y	Agriculture, cultural values
8	Red-vented bulbul (<i>Pycnonotus cafer</i>)	Y	Agriculture, biodiversity
9	Little fire ant (<i>Wasmannia auropunctata</i>)	Y*/N	Health, biodiversity, tourism, cultural values
10	Brown tree snake (<i>Boiga irregularis</i>)	N	Biodiversity, infrastructure, health

* This species was listed in the Global Invasive Species Database as being in Fiji. However, Fijian experts we talked to did not believe the species had been found in Fiji as yet.

3 Review of Invasive Species

We undertook a more in-depth desk top assessment of what is known about the species listed in Table 1. The type of information we collected is outlined in Appendix A. This review was broader than just Fiji as there is relatively little data found on the Fijian impacts. Some general thoughts on the findings of our review are outlined below with more comprehensive information found for these species (but also some of the initial list) included in an accompanying spreadsheet. This is being circulated to various organizations for their use.

- General information
 - Many species were invasive elsewhere (the giant African snail is listed as invasive in 60 countries).
 - The breeding/reproductive biology is fairly well known for most species.
 - There is relatively good information on the ways these species are spread and their common distribution pathways. This means that following eradication or control, the common distribution pathways could be monitored to ensure reintroduction does not occur. This could be done successfully and inexpensively for some species. For example, the pest species mongoose were introduced as a biological control agent for rats and snakes; and Hays and Conant (2007) consider that they are unlikely to establish without human intervention. In the last year, there have been two mongoose incursions in Samoa and New Calendia from mongoose being transported with cargo (Souad Boudjelas, PII, pers. comm., 19 September 2011). Therefore, if eradication from an island was successful, a follow-up campaign with promotional material that described the negative impacts of mongoose (e.g., killing of native animals) may stop re-introduction.

For other species, monitoring would be more costly and potentially less effective. For example, the giant African snail can spread through a variety of accidental and deliberate human-assisted mechanisms explaining why it is invasive in 60 countries.

- The economic impacts of invasive species are lacking in the literature, particularly in a South Pacific/Fiji setting – possibly because of the challenges with undertaking economic assessments where data are scarce and capacity is low. However, in at least one instance there has been an attempt to determine the economic cost of damage. The taro/dalo beetle can cause damage in up to 40% of the taro crop. Using an approximate calculation, this could be around FJ\$4.8 million (assuming an annual average crop value of FJ\$12 million (Autar & Vasuidreketi 2007)).

4 Assessing the economic impact of invasive species

The economic impact of invasive species falls into two broad categories—impact on use values (direct, indirect and option values) and impact on non-use values (existence values) (Emerton & Howard 2008). There is a range of methods used to estimate the monetary value of the costs and benefits of invasive species. The report does not provide a comprehensive overview of these methods as they are widely documented in the literature (e.g., Emerton & Howard 2008). In general, however, it is relatively straight-forward to estimate the direct costs (or benefits) that may be associated with the introduction of a species. For example, the infrastructure or agricultural damage an invasive species may cause. The other costs (or benefits), however, are much more expensive and challenging to quantify, often requiring a detailed survey design and statistical analysis. To use these latter

methods (e.g., revealed or stated preference methods) therefore requires specialised skill sets.

5 Tools to assess the economic impact of invasive species

While journal articles exist outlining the results of economic assessments of invasive species there are few documents that outline how such assessments should be made. Probably the most comprehensive document to describe the process of undertaking an economic assessment of invasive species is The Global Invasive Species Programme (GISP) toolkit (Emerton & Howard 2008). This toolkit outlines a series of modules for assessing the impact of invasive species covering areas such as understanding the economic causes of invasions, defining invasive-related costs and benefits, and valuation of ecosystem impacts. High-level guidance is provided for each module, but it would not be sufficient for non-experts to implement easily.

The (monetary) quantification of economic impacts module provides a good general description of a number of methods available but would benefit greatly from complementary guidance/examples of how to actually undertake such a valuation. This should be aimed at the non-expert to allow a greater number of agencies and organisations to use economic impact assessments are part of their decision-making processes.

While other more economic assessment or valuation guidance does exist (e.g., Babier et al. 1997; Letson & Milson 2002; Environmental Protection Agency 2003; Kumar 2010) they also tend to be high-level and, given their general nature or application to other issues, were less useful for non-experts wishing to assess the economic impact of an invasive species.

6 Economic assessment of Asian subterranean termite

To facilitate the economic assessment of a recently recognised invasion of the Asian subterranean termite (*Coptotermes gestroi*) we have agreed to assist a University of South Pacific Masters student, Ravi Prasad, supplement his thesis on bio-control agents for this species with an economic cost assessment.

Biosecurity Fiji, while not collecting economic data, have collected information on number of houses/trees inspected, number of houses/trees infested and the actions taken. This information can be used to form the basis of an economic assessment of current costs and to also to estimate potential future costs of termite eradication or management efforts. This will provide Biosecurity Fiji with additional information to confirm or rationalise their eradication/control campaign response (this response recently switched from eradication to a control campaign). It will also provide some training (albeit only to one person) in the area of economic assessment in the region. Incursion data has been collected and the analysis is ongoing. The project team continues to support Ravi Prasad and there is potential for further analysis of the data. It will be considered as part of the proposed Phase 2 work.

7 Gaps

Much information is required to effectively manage invasive species. This includes biological information related to reproduction, ecological habitats, pathways through which species spread and the ability of an invasive species to adapt to new ecosystems, the extent and type of negative (or positive) impacts these species have in countries they invade, the economic costs of the damage they incur, the mechanisms that can be used to eradicate or control a species, and the economic benefits and costs of eradication or control options.

There seems to be relatively good progress made on the collection of the biological aspects of many invasive species in that we generally know the reproductive capacity and conditions, ecosystems and habitats where the species may prosper, and the pathways of spread. Most of this knowledge appears to be gained through research by academics and graduate students (often masters students in the Pacific or visiting scholars) and NGOs who have specific interests in one or more types of invasive species. In some areas, a relatively high level of effort seems to be put into the eradication of certain invasives species (e.g., mammals from islands or species that have caused significant agricultural damage to commercial crops). This work is largely a mix of government-led (e.g., Taro/dalo beetle eradication campaign, or the recent Asian subterranean termite campaign) and NGO-led initiatives (e.g., Birdlife International Fiji Programme on rat and goat eradication campaigns). While these efforts are far from complete, there appears to be some capacity to undertake the biological aspects of invasive species prevention, control and eradication in Fiji (and the Pacific) and some funding (but probably not enough) to support it.

The one area where there appears to be relatively little information or the capacity to collect information is on how the presence of an invasive species affected (or would affect) local economies and livelihoods and the potential costs of prevention, eradication or control.

This confirmed our *a priori* knowledge that there was a dearth of economic information on most invasives species in Fiji (and the Pacific Islands more generally) that hinders the decision-making abilities of governments and NGOs about whether an eradication/control programme should be pursued, and in the selection of the appropriate (cost-effective) measures for their eradication or control.

Some of this work is proposed in the second phase of work.

8 Recommendations

Information on the economic impacts of invasive species is important both for government agencies to determine the level of effort they should take to prevent, eradicate or control an invasive species and for NGOs to assess their efforts around invasive species management. Given the number of invasive species and the high risk of introduction, Pacific islands' resources will be continually stretched to meet prevention, eradication or control needs to deal with invasive species. We recommend that the following measures be undertaken, in the light of limited capacity in the region to conduct economic assessment of invasive species and their management:

1) Professional training:

Given the lack of capacity to undertake economic assessments of the impact of invasive species, in-country training to provide some basic economic skills to government agency staff and the NGO sector would greatly assist with bridging the knowledge gap and provide Fiji with an ability to undertake these kinds of analyses on a more routine basis.

There are two aspects to the economic assessment of the impact of invasive species. One involves the direct use costs (or benefits) associated with the introduction of a species (e.g., damage to infrastructure or agricultural production). The other involves the indirect use or non-use costs (or benefits). As a greater skill base is necessary to undertake the estimation of the costs and benefits in this latter category, the delivery of any training in this area should be cognizant of this. Therefore, the structure of any training programmes should start with how to illicit and estimate direct use costs and get participants comfortable with undertaking these types of analysis. The indirect-use and non-use costs and benefits should be the focus of subsequent training programmes.

2) Invasive species assessment tools:

Toolkits and guidance documents (e.g., GISP toolkit (Emerton and Howard, 2008)) have been developed to assist those undertaking economic assessments on the impact of invasive species. These toolkits, however, are frequently written in a way that it is challenging for non-experts to use. To increase the ease of use of these tools, detailed step-by-step guidance on how each action is applied to a real case study would be useful. A series of case studies should be undertaken not only to provide the information to the relevant government agencies and NGOs but also to document the process so that it complements and provides useful guidance to accompany these toolkits.

3) Community Assessments:

There is little information on the extent, nature, and degree of impacts for many invasive species in Fiji. Therefore, by the time issues related to invasive species are identified the extent of damage or spread and cost of management has risen dramatically, making it more costly to undertake eradication or control measures.

To help fill this information gap, a series of community-based surveys to elicit the impact of various invasive species would be useful. The surveys should focus on identifying the impacts and extent of damage of existing invasive species, and determining the level of awareness of a broader range of invasive species (particularly those species whose impacts are less visible or whose primary impact is on biodiversity), what eradication or control measures communities use (or would be willing to use), and what mechanisms they find useful for obtaining information on invasive species.

Ideally, any surveys would be conducted by Fijian-based persons to develop the in-country/regional capacity.

4) Routine invasive species assessment:

Once in-country economic assessment capacity has been developed the next step would be to assist the relevant government agencies (e.g., Biosecurity Fiji) strengthen their decision-making process and develop protocols to prioritize government agency resources based on the level, extent and potential impacts of a species. Similarly, NGOs working on the eradication of various species must be encouraged to undertake similar cost-benefit (including cost effectiveness) assessments to complement their eradication campaigns. Factored into these assessments must be the cost of prevention as well the cost of preventing re-invasion.

5) Increasing public awareness of invasive species:

One of the challenges facing governments and NGOs in the prevention, eradication or control of invasive species is public awareness. Often an invasive species has similar characteristics to a native species. This can make it difficult for local populations to know whether they have or have not seen an invasive species and therefore whether they need to manage it. Coupled with this is the lack of understanding of how invasive species are moved between sites. Education campaigns should be a key component of any invasive species management effort.

9 Phase 2 of this project

We have proposed some of this work in a phase 2 proposal for looking at the economic impact of invasive species in the Pacific. In particular, the following activities have been proposed:

- Training course for professionals (both government agency and NGOs) in Fiji on how to undertake an assessment of the direct economic costs of invasive species. The course will cover technical material on how to estimate the economic costs, and how to write and present the results to peers or supervisors. The course will be open to persons in the Pacific region but numbers will be limited to 8-12 persons. Participants will be selected using a pre-defined set of criteria.
- Step-by-step economic assessment guidance through a case study to complement various modules of the GISP toolkit. It is not envisaged in this Phase that the case study will cover (or at least provide much detail on) the indirect and non-use values, given the complexity of these assessments. A simple spreadsheet tool will also be developed to provide structure around the assessment of economic costs.
- Community survey that elicits information on the species outlined in Table 1. This survey aims to provide information on the level of awareness of these species, the type and extent of damage caused, and the prevention/eradication/control measures being used.

- Public awareness advocacy material is developed to generate political support for invasive species management. These will be aimed at Fijian and other Pacific leaders, relevant organisations including donors and the public.

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Appendix A – Invasive Species information collected

The data collected on the points below have been compiled into an excel spreadsheet and will be circulated to relevant agencies and organisations in the Pacific and will be made publicly available with the other material developed in Phase 2.

Current distribution and potential spread

- Current distribution in country (e.g., urban areas, isolated islands)
- Current distribution within the Pacific/globally (e.g., neighbouring countries)
- Status of species within the country (e.g., domesticated, naturalised, invasive)
- Pathways: human-assisted, natural (wind- or animal-dispersed seeds, vegetative growth, readily dispersing young)

Biology/ ecology

- Reproduction frequency and quantity (e.g., annual reproduction, number of offspring per breeding season)
- Method of reproduction/ propagation (e.g., seeds)
- Time to maturity/ breeding adult stage
- Longevity
- Habitat preferences/ tolerance
- Resources used by the species (plants, animals)
- Known biocontrols or natural enemies
- Effect on habitat (e.g., allelopathic plants, act as ecosystem engineers)

Impacts

- Economic impact
 - Sectoral impacts
 - Agriculture/tourism/industry/fisheries
 - “production ecosystem” (e.g., trade flows)
 - Production/consumption losses
 - Changes in cost/revenue of people’s affected by the species
 - Economic value
 - Direct costs
 - Indirect costs
 - Non-use costs
 - Option values
- Social/cultural impacts (e.g. income, employment)
- Human health and welfare impacts
- Human development system and infrastructure impacts
- Natural ecosystems impacts: terrestrial, freshwater and marine (ecosystem services)
- Other risks (e.g., fire, flood)
- Useful traits (positive impacts) – beneficial economic, social/cultural impacts

Preventing and managing invasion

- Preventing introduction
 - At different pathways (land, aerial, water/marine)
 - At sites (probability of detection, risk assessment/ quarantine, information available, research needed)
- Assessment and management type
 - Eradication methods
 - Control/ containment methods
- Restoration methods after invasion