FEASIBILITY STUDY REPORT

The Management of Invasive Plants within a Proposed Protection Area, Olum Watershed, Kosrae, Federated States of Micronesia

Title: Feasibility Study for the Management of Invasive Plants within a Proposed Protection Area, Olum Watershed, Kosrae, Federated States of Micronesia

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Version History:

VERSION	DATE	AUTHOR	REASON FOR CHANGE
Version 1	21 09 12	John Mather	
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Version 3	7 11 12	John Mather	Changes as per peer review by Glen Coulston, Biodiversity Threats Manager, Department of Conservation, Northland, New Zealand.

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EXECUTIVE SUMMARY

This Feasibility Study was undertaken by the Pacific Invasives Initiative (PII). The study was undertaken to determine the feasibility of managing invasive plant species suspected of threatening an area of lowland native forest on Kosrae island, Federated States of Micronesia. A proposed protection area within the forest has high biodiversity, water supply and cultural values.

Kosrae is the easternmost island of the Caroline Group and lies at approximately 5 degrees north of the equator, between Guam and the Hawaiian islands. The island is 110 square kilometres in size and has significant areas of intact upland native forest.

PII was invited to complete the Feasibility Study for the Kosrae Conservation and Safety Organisation (KCSO). KCSO is a non-government organisation which has received funding from the Critical Ecosystem Partnership Fund (CEPF): this study forms part of the Protecting Kosrae's Upland Forest project with funding assistance from CEPF.

The Feasibility Study considers management options for ten invasive plant species (target species) which were specified by KCSO. KCSO invited the author to provide comment on other invasive plant species detected on Kosrae and some general comment regarding invasive plant training needs and management. A further seven invasive plant species are included in this report and recommendations provided for invasive plant training and management options.

The proposed protection area is a good example of rare, relatively undisturbed, lowland forest. Only one of the specified target plant species was found to infest the proposed protection area; this species should be easily controlled. Seven of the KCSO specified target species are established elsewhere within the proposed protection area's watershed. Management actions are recommended to prevent their further expansion toward the protection area and possible encroachment of some of these species into the area's forest margins.

Two of the recently detected plant species are in very small populations that could establish within the margins of the proposed protection area. These should be immediately destroyed to minimise risk of their further spread. Other identified plant species require research to determine their native range status and possible inclusion in future biocontrol programmes.

The management of invasive plants, both within the proposed protection area and elsewhere within the wider watershed, is very feasible. The cost of a 5 year management programme in these areas is relatively low at approximately $58,000 (US) over 5 years. The recommended management programme involves including the landowners and members of the proposed protection area's neighbouring communities. This will help ensure that there is community awareness of the invasive plants and their environmental effects, community participation in reducing their further spread at reasonable cost and that management is in-line with a widely supported ethic of minimal herbicide use on Kosrae. Some professional assistance is recommended to achieve the effective control of the woody weed species.

The Feasibility Study Report will be used as a resource to determine best-management practice for the specified target species, both within the proposed watershed protection area and at other infested sites in Kosrae. It is intended to be a reference document for requests to formally protect

areas within Olum watershed and to support future funding applications. Information from the report may also be used when Kosraean authorities review species that may become priority targets for future invasive plant management programmes. Funding for **implementation** of the management of invasive plants within the proposed protection area and Olum watershed has **not yet been secured**.

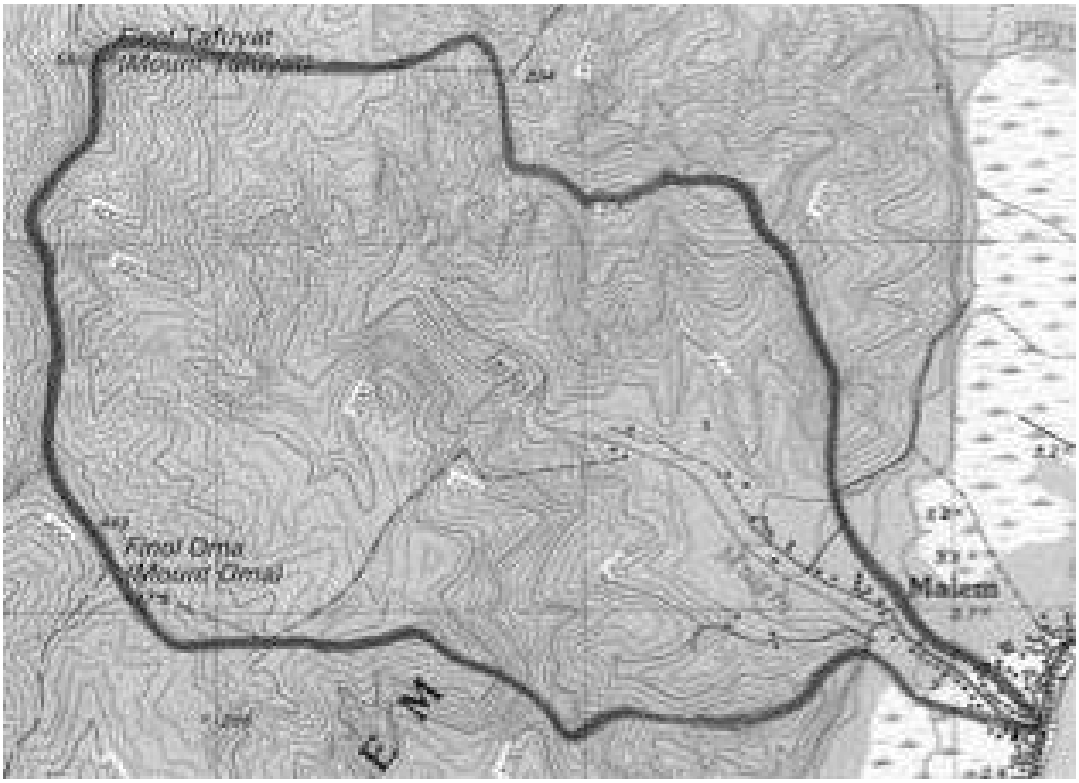
KCSO should coordinate the invasive plant management project for the Olum watershed working collaboratively with Kosraean government agencies and the community. KCSO should also continue to seek occasional expert advice and mentoring from an appropriate external agency.

The budget includes provision for a training course so that team members can become certified in the use of recommended herbicides. The budget does not include the provision of further training in aspects of invasive plant management such as data collection and storage, developing invasive species management plans or upskilling in effective control techniques. KCSO and Kosraean authorities should continue to build capacity in these areas and seek funding to ensure that appropriate training is undertaken.

In summary, the management of invasive plant species both within the proposed protection area and wider watershed is recommended to ensure that the biodiversity, water supply and cultural values of the lowland native forest are protected. **The project is feasible**.

Part of the Olum watershed (Photo: Kosrae Conservation and Safety Organisation)

Native forest within the proposed protection area, Olum watershed



The Olum watershed with Malem village on the coast

Olum watershed with the 3.3 hectare proposed protection area identified

1. INTRODUCTION

The Pacific Invasives Initiative have completed this Feasibility Study report in collaboration with the Kosrae Conservation and Safety Organisation.

The Pacific Invasives Initiative (PII) is a multi-disciplinary team of invasive species specialists, based at the University of Auckland, which works with different agencies including Pacific Island Countries and Territories to strengthen capacity to effectively manage invasive species threats. The mission of the Pacific Invasives Initiative is that: *"the natural heritage and peoples of Pacific Islands Countries and Territories (PICTs) are protected from the threats of invasive species by Pacific people".*

PII achieves this by providing technical advice, assistance with proposal and project design, project review, access to experts and formal job training to Pacific agencies who are working or planning to work on invasive species projects.

The Critical Ecosystem Partnership Fund (CEPF) has provided funding to the Kosrae Conservation and Safety Organisation (KCSO) to undertake this Feasibility Study Report as part of the Protecting Kosrae's Upland Forest project.

CEPF is a joint initiative of l'Agence Française de Développement, Conservation International, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation, and the World Bank. CEPF provides grants to civil society organisations to help protect biodiversity hotspots, which are Earth's most biologically rich yet threatened areas. A fundamental goal is to ensure civil society plays a critical role in achieving biodiversity conservation. This project is directly linked to the CEPF strategic direction 2: *Strengthen the conservation status and management of 60 key biodiversity areas.* The project seeks to maximise efforts to protect Kosrae's upland forest ecosystem and its biodiversity. Kosrae's upland forest is one of 60 sites prioritised for intervention by CEPF in the Polynesia-Micronesia Hotspot. The project seeks to designate and manage the Olum watershed area and upland forest as a protected area in Kosrae.

KCSO is an incorporated non-profit organisation, working with communities, government and non-government agencies to conserve Kosrae's natural resources and biodiversity. KCSO has three main programmes working in marine conservation, terrestrial conservation and environmental education.

The mission of the Kosrae Conservation and Safety Organisation (KCSO) is: *"to sustainably manage and protect Kosrae's biodiversity and natural heritage through community engagement and partnerships for the benefit of present and future generations".*

KCSO has requested PII complete component 4.4 of the project: Protecting Kosrae's Upland Forest, as submitted to CEPF. Component 4.4 of the project has a Product / Deliverable: Feasibility study completed on invasive weed eradication and control within the July – September 2012 timeframe; and specifically to conduct feasibility study to assess whether it is feasible to do an eradication operation or a control management programme on invasive weeds. This document is the resulting Feasibility Study Report.

The main purpose of the Feasibility Study Report is:

1. To assess the feasibility of management options (i.e. prevention, eradication, control or do nothing) for ten invasive plants (target species), as specified by and of concern

to KCSO, within a proposed protection area in the Olum watershed. The Olum watershed contains an area of high biodiversity value native forest on Kosrae.

Additionally, KCSO has requested PII to:

2. Provide general management options for the target species suitable for other infested sites within Kosrae.

3. Provide comment as to other invasive plant species identified in Kosrae while undertaking the feasibility study and recommend management actions.

4. Provide comment and recommendations as to any potential invasive plant training requirements for agencies in Kosrae.

The Feasibility Study Report will be used as a resource to determine best-management practice for the target species, both within the proposed watershed protection area and at other infested sites in Kosrae. It is intended to be a reference document for requests to formally protect areas within Olum watershed and to support future funding applications. Information from the report may also be used when Kosraean authorities review species that may become priority targets for future invasive plant management programmes.

The audience for the Feasibility Study are KCSO, Government and NGOs, both within Kosrae and elsewhere, CEPF and other funding bodies.

Thanks is extended to the following people and organisations for their support, help and advice in completing this Feasibility Study: KCSO and specifically Executive Director Andy George; Terrestrial Programme Manager, Jacob A Sanney; Environmental Educator, Dison Kephas; Erick Waguk, Forester, Kosrae Island Resource Management Authority (KIRMA); Leonard A Sigrah, Invasive Species Coordinator, KIRMA; Jason Jack, Invasive Species Coordinator, Department of Resources and Economic Affairs (DREA); Hamilson Phillip, landowner, Itut; John Marrdin, farmer, Utwe Municipality; Carlos Cianchini, Project Assistant, Pacific Adaptation to Climate Change (PACC); Reverend Madison Nena, Small Grant Programme Coordinator; Natasha Doherty, Bill Nagle and Souad Boudjelas, Pacific Invasives Initiative; Carola Warner, University of Auckland.

2. GOAL, OBJECTIVES and OUTCOMES

2.1 Goal

The goal of the proposed project is:

- That the Olum watershed and associated upland forest is designated and managed as a protected area in Kosrae, protected from the impacts of invasive plants.

Achieving this goal is important because the Olum watershed and upland forest area in Kosrae provide the community's water supply; invasive plants often exacerbate instability of land, resulting in siltation and degraded water quality; the island of Kosrae has areas of high biodiversity value forest, including areas of cloud forest (i.e. forest often covered by persistent cloud cover and containing, for example, a range of mosses and ferns) which are rarely found in tropical island locations; the forest contains many endemic and native plant species which require an environment

free from invasive plant impacts to ensure their future survival and regeneration. There is an established eco-tourism business operating within the watershed where people observe native and endemic plant species and areas of historic and cultural significance. There is also a pride among local landowners that they live near such an outstanding ecological area and can play a part in protecting it. School groups regularly visit the proposed protection area to learn about the biodiversity and other values of an intact forest ecosystem and to see visual evidence of Kosraean history.

The additional goals, as requested by KCSO are;

- deciding best management options for the target species suitable for other infested sites within Kosrae; and
- identifying other invasive plant species while undertaking the site visit for the feasibility study and recommending management actions

These additional goals are important in advancing a rational, logical, cost-effective strategy for invasive plant control on Kosrae island. Deciding the priority species is pivotal in implementing any future invasive plant management policy.

2.2 Objectives and Outcomes

The objectives and outcomes of the proposed project are:

1. **Regarding the proposed protection area within the Olum watershed**: only one of the target species (Giant bramble *Rubus moluccanus*) was observed to be present, however it was found to be established elsewhere within forest areas of Kosrae. It was found in low numbers and appeared to be relatively non-invasive within the forest habitat. There is uncertainty as to whether it is native to Kosrae or an introduced species. None of the remaining target species were found within the proposed protection area, but six species are established in the lower watershed within 1 kilometre of the protection area (Siam weed *Chromolaena odorata,* American joint vetch *Aeschynomene americana,* wedelia *Sphagneticola trilobata,* dayflower *Commelina diffusa,* paddle grass *Ischaemum polystachyum,* bottle gourd *Luffa cylindrica*). Three of these species (wedelia, dayflower and bottle gourd) are relatively shade tolerant and could possibly establish under the forest canopy of the proposed protection area. They should be managed to minimise the risk of future invasion into the protection area. Managing these species within the Olum watershed is a **site-led programme** (N.B. a site-led programme is focused on minimizing the numbers and impacts, or containing the distribution, of invasive plants in a specified area).

2. **Regarding the ten target species and their management on the wider Kosrae island**: the target species plants vary in their occurrence, distribution and density and it is unlikely that eradication can be achieved for any of them. Two of the ten species (bronze-leaved clerodendrum *Clerodendrum quadriloculare* and leucaena *Leucaena leucocephala*) could be controlled to a zero density level, i.e. the target species are prevented from flowering, fruiting and seeding so that the adult plant population stays at zero. Six species (Mile-a-minute *Mikania micrantha,* Siam weed *Chromolaena odorata,* American joint vetch *Aeschynomene americana,* wedelia *Sphagneticola trilobata,* dayflower *Commelina diffusa*

and paddle grass *Ischaemum polystachyum*) are well established and widespread over significant areas of coastal Kosrae and should be controlled to protect biodiversity values or to prevent other infestations from establishing. Two of the target species (giant bramble *Rubus moluccanus* and bottle gourd *Luffa cylindrica*) are sporadically established within forest areas of Kosrae, but were not invasive within the observed habitats. There is uncertainty as to whether three of the target species (paddle grass *Ischaemum polystachyum*, giant bramble *Rubus moluccanus* and bottle gourd *Luffa cylindrica*) are native to Kosrae; their native range needs to be further clarified. Biological control options should be investigated for five of the target species (mile-a-minute *Mikania micrantha,* Siam weed *Chromolaena odorata,* wedelia *Sphagneticola trilobata,* dayflower *Commelina diffusa* and paddle grass *Ischaemum polystachyum*). The taxonomy of one of the target species (bottle gourd *Luffa cylindrica*) needs to be clarified by an expert herbarium. Managing the ten target species on the wider Kosrae island is a combination of **species-led programme** for the low-incidence plants and satellite infestations, capable of being reduced to zero density, and a **site-led programme** where the remaining species are only controlled if they threaten the biodiversity values of identified high-value biodiversity areas on the island (N.B. a **species-led programme** generally aims for complete eradication or control to zero density of the species from a site).

3. **Regarding other invasive species recorded as present on Kosrae**: a further seven invasive plants were recorded as present on Kosrae. Of these, two (Water hyacinth *Eichhornia crassipes* and Honolulu rose *Clerodendrum chinense*) are recommended for eradication programmes and two (lantana *Lantana camara* and blue morning glory *Ipomoea indica*) for control to zero density. The three others (mission grass *Pennisetum polystachyon,* white ginger *Hedychium coronarium* and merremia *Merremia peltata*) require further investigation as to taxonomy, confirming native range and/or invasiveness, and dependent on these results, their suitability for control or possible future biocontrol programmes should be further investigated. Only one of these seven species (merremia *Merremia peltata*) is found within the proposed protection area.

4. **Regarding invasive plant training requirements for Kosrae:** Three levels of expertise are generally required for any invasive plant management programme:

   A). A national invasive pest management strategy: A high-level national invasive species management strategy will determine which invasive plants (or other invasive species) will be controlled, the level of management for each (e.g. eradication, control, awareness and encouragement programmes, biocontrol research), it would identify and quantify funding, include any rules which may require specified actions and identify how different agencies could work together.

   B). Thorough programme (or project) planning: Management actions are pre-planned for each weed species to ensure that the target plants' ecology (e.g. optimal time for control to prevent further seeding) is taken into account so that the most effective control is achieved. Also, suitable and effective methods, surveillance and follow-up control is established for any site-led programmes. Any seasonal requirements are also taken into account.

C). Suitable and effective field skills: So that any control work undertaken is effective and suitable to the target plant or site, health and safety requirements are met, monitoring of the work and follow-up control is completed when required.

Further advice, mentoring and training for agencies on Kosrae, in each of the expertise levels, would help ensure that an effective, efficient and integrated invasive plant / biosecurity function is further developed.

The objectives that this project will achieve and the outcomes that will be seen as a result of achieving these objectives are:

Objectives	Outcomes
1. *Objective 1* For the proposed protection area within the Olum watershed: Target invasive plant species are managed preventing them from infesting the protection area.	1.1 *Outcome* The upland forest's natural native vegetation, regeneration and successional processes, which invasive plants otherwise disrupt, is maintained.
	1.2 *Outcome* The Malem community continue to have access to clean and silt-free water
	1.3 *Outcome* Eco-tourism activity can continue within the watershed, unhindered by any encroachment of the target exotic plant species.
2. *Objective 2* For the Olum watershed: Management recommendations are provided for the target invasive plant species.	2.1 *Outcome* That management recommendations are followed and that prevention, eradication, control, containment or do nothing options for the target species is achieved.
3. *Objective 3* For Kosrae: The distribution of the target invasive plant species is surveyed and recorded over the wider Kosrae island environment.	3.1 *Outcome* Knowledge of plant distribution will assist in providing sound management recommendations.
4. *Objective 4* For Kosrae: Other invasive plant species detected on Kosrae, are recorded and future management options recommended.	*4.1 Outcome* The detected plant species are eradicated, controlled or managed so that biodiversity, amenity and economic values on Kosrae are protected.
5 Objective 5 Recommendations are provided for further invasive plant management training needs	*5.1 Outcome* Biosecurity and conservation practitioners on Kosrae are well trained in field skills, planning and managing all Kosraean biosecurity and conservation tasks.
	5.2 Outcome All relevant agencies on Kosrae are working effectively and collaboratively to ensure that biosecurity and biodiversity programmes are efficient.

3 THE SITE

The Olum watershed project site is located on the island of Kosrae, Federated States of Micronesia. Kosrae is a single volcanic island located near the eastern end of the Caroline group in the Pacific Ocean. It is about 500 kilometres north of the equator and 1,000 kilometres southeast of Guam. The island is roughly triangular in shape and has an area of about 10,631 hectares (42 sq. miles). The

mountainous areas make up about 70% of the island. The foot-slopes, alluvial fans and bottom lands make up about 15% of the land area (*Soil Survey of Kosrae* by William E. Laird, Soil Conservator). Over 80% of the population (the population of Kosrae is approximately 7,700 people) live within 500 metres of the coast. Subsistence farming is the main land use on Kosrae.

The project site is within the Olum watershed which is on the south-eastern side of Kosrae. The watershed is 310.4 ha in size. The municipality of Malem (population approximately 1,500), is situated in the coastal area of the watershed with most dwellings established within 1.5 km of the proposed protection area. Approximately 100 Itut landowners occupy the area of the watershed near the middle of the valley. This area is characterised by parcels of agro-forestry cropping but transitions to native forest as the land steepens into the upper watershed. Landowners in Itut have currently agreed to formerly protect a 3.3 ha area of the watershed within the upper valley. It is a rare remnant of lowland (i.e. below 100 m level) Kosraean forest. The *Protecting Kosrae's Upland Forest* project team hope to eventually have at least 150 ha of the 310.4 ha watershed formally protected and recognised as the first watershed protected area under the Kosrae Protected Areas System.

There are no dwellings within the protection area but two houses belonging to the landowners and an approximate 0.5 ha area of agro-forestry (breadfruit, coconuts, bananas, mangoes, citrus and kava) are adjacent to it.

A formed gravel road extends along the Malem Valley from the Malem municipality to the Itut community and ends at the landowners' dwellings.

A formed walking track extends through the protection area. An established eco-tourism business allows visitors to tramp through the 3.3 ha protection area and onward to Mount Oma, viewing relics from Japanese occupation during World War 2 and a network of tunnels extending into the hillsides. Some tunnels are within the 3.3 ha protection area with the remainder being within the forest above it. Although steep in places, all of the 3.3 ha area currently approved for protection is accessible.

Almost all land within the watershed below the 100 metre elevation level is privately owned. Land above 100 metres is currently owned by the Kosraean Government; however, there are community claims on some of this land.

The project site is currently used as a watershed for the collection of a permanent water supply to the Itut and Malem communities. A dam is established on the Olum Stream adjacent to the project site.

The site is occasionally used by local hunters for pig or pigeon hunting. There is a one month season for hunting in January. Pig numbers appear to be low and no pig-rooting or other damage was observed in the proposed protection area.

There is a population of the endemic "Tuhram" Kosrae white-eye (*Zosterops cinereus*) State bird within the protection area.

The forest within the 3.3 ha protection area and wider watershed is dominated by mature native and endemic species. This dominance helps to ensure a reliable, high quality water supply and provides a unique experience to eco-tourists wanting to view native Kosraean plants. The upper

Olum watershed area hosts a diverse tropical premontane rainforest life zone with steep mountains that is essentially undisturbed. Dr Wayne Law, New York Botanical Garden, will work with KCSO to gather accurate baseline information of the forest species and set up monitoring plots within the Olum watershed. This work is scheduled to be completed by 30 September 2012.

There is a 200 square metre area of agro-forestry above the 3.3 ha proposed protection area. Banana and breadfruit are planted in this small area. This cropped area is possibly more vulnerable to invasive weed encroachment through exotic plants establishing in any bare soil. Weed species could be vectored to the site through bird-borne, wind-borne or human pathways.

The watershed area receives approximately 7,500 mm rainfall per year. Kosrae has a tropical climate that is heavily influenced by the NE trade winds which prevail from November to December and April to May. The trade winds bring frequent heavy rainfall and average temperature ranges are from 26 to 27 degrees Celsius (79 to 81 degrees Fahrenheit) all year.

Kosrae has experienced occasional drought conditions in the February to April dry season. All droughts have occurred as a result of El Nino weather patterns.

The target weed species do not infest the proposed protection area, apart from giant bramble (*Rubus moluccanus)* which is present in very low numbers. The front of any possible future weed invasion from the remaining target weed species into the proposed protection area is near the landowners dwelling, 100 metres from the protection area where four of the target species are established; and approximately 500 metres southeast along the road to Malem village where a further two species are established. The species and size of infestations is described in Section 4.2 Impacts.

4 THE TARGET SPECIES, IMPACTS AND BENEFITS OF MANAGEMENT

4.1 Target Species

Ten target plant species were specified by KCSO within the Project Proposal. These species are:

- Bronze-leaved clerodendrum (*Clerodendrum quadriloculare*)
- Leucaena (*Leucaena leucocephala*)
- Mile-a-minute (*Mikania micrantha*)
- Siam weed (*Chromolaena odorata*)
- American joint vetch (*Aeschynomene americana*)
- Wedelia (*Sphagneticola trilobata*)
- Dayflower (*Commelina diffusa*)
- Paddle grass (*Ischaemum polystachyum*)

- Giant bramble (*Rubus moluccanus*)
- Bottle gourd (*Luffa cylindrica*)

Three other invasive species were recorded by the author as being present on Kosrae and are recommended for prompt active management. These plants are currently present in very low numbers and control programmes should be implemented as soon as possible. These species are:

- Water hyacinth (*Eichhornia crassipes*)
- Honolulu rose (*Clerodendrum chinense*)
- Lantana (*Lantana camara*)

Another four species should be investigated, so that ecological aspects such as their taxonomy, native range and invasiveness can be clarified; and management options considered:

- Blue morning glory (*Ipomoea indica*)
- Mission grass (*Pennisetum polystachyon*)
- White ginger (*Hedychium coronarium*)
- Merremia (*Merremia peltata*)

Photos of these plants on Kosrae island can be seen in Appendix 2. General detail as to each of these plants' **current distribution** on Kosrae, **ecology**, **stage and effect of invasiveness,** and **likely effectiveness of control methods** follows.

Pacific INVASIVES INITIATIVE

Table 1: For the ten plant species specified within the project proposal

Plant species and weed risk assessment scores	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
Bronze-leaved clerodendrum (*Clerodendrum quadriloculare*) WRA score: 11	Localised infestations: Tofol x 2; Yeseng (1 km south of Malem); Utwa. Approximately 500 plants.	Shrub or small tree, 2 to 5 m high, leaves 15-20 cm, dark green above, purple below. Fruits with viable seed, bird dispersed. Suckers from roots. Shade tolerant.	Early stage of invasion. Current sites either near or at planted areas. Shade tolerant. May establish within a forest preventing regeneration of native plants.	Reduction to zero density is achievable.	No	No
Leucaena (*Leucaena leucocephala*) WRA score: 15	2 infested areas in Tofol. Approximately 100 plants.	Fast-growing, nitrogen-fixing shrub / small tree. Seeds in pods. Seed usually long-lived (20 years or more). Problem weed of especially roadsides and coastal areas.	Very early stage of invasion. Some control work completed. Prefers open habitats and not known to invade an undisturbed closed forest.	Reduction to zero density is achievable.	No	No
Mile-a-minute (*Mikania micrantha*) WRA score: 25	Well established over an approximate 10 km coastal area, Tafunsak to Walung Conservation Area. Small satellite infestations e.g. Lelu, Tofol.	Vigorous, perennial creeping climber. Grows in open areas, forest margins. Stems take root on contact with the ground. Wind-borne seed but also clings to clothing or	Established for at least 20 years in coastal northeast Kosrae. Could establish over most coastal areas. Control of satellite populations would slow the spread.	Control satellite infestations so that the plant is restricted to the coastal northeast area of Kosrae. Control to protect areas of high biodiversity value. Investigate	No	No

Plant species and weed risk assessment scores	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
		machinery.	Out-competed by *Merremia peltata.* Kills other plants by smothering and excluding light.	biocontrol options.		
Siam weed (*Chromolaena odorata*) WRA score: 28	Airport margins and north-eastern coastal Kosrae heavily infested. Satellite infestations in Malem area.	Fast-growing perennial shrub, 1.5 to 2.0 m high. Shallow, fibrous root system. Seeds wind-borne or cling to clothing, machinery. Stems can take root on contact with the ground. Roadsides, forest margins, open areas. Can grow in shade but seldom sets seed.	Well established in north-eastern Kosrae. Spreading along roadsides. One gall-forming insect is attacking Siam weed on Kosrae. The identification of this species needs to be confirmed. May prevent regeneration of native species in open or forest margin habitats.	Possible to slow the spread with an on-going programme of controlling satellite infestations. Control to protect invasion into the open or forest margin areas of high biodiversity value areas. Further biocontrol options should be researched.	No	Yes
American joint vetch (*Aeschynomene americana*) WRA score: 12	Scattered infestations, especially along all roadside locations.	Annual or perennial herb, to 2 m high. Nitrogen-fixing legume. Long-lived seeds. Forms moderately dense patches. Has been recorded as an	Recorded on Kosrae in 1996. Common on many roadsides. May prevent the regeneration of native species in open habitats.	Difficult to sustainably reduce infestations now, especially with a lot of dormant seed present. Control to protect at-risk high-value biodiversity	No	Yes

Plant species and weed risk assessment scores	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
		invasive plant of wetlands.		areas.		
Wedelia (*Sphagneticola trilobata*) WRA score: 13	Well established at many roadside and open site (e.g. school, church) locations.	A mat-forming perennial herb. Stems root at the nodes. Common in agricultural areas, stream margins, prefers sunny sites.	Herbarium sample collected from Kosrae in 1996, with description: "naturalized and locally abundant along roadsides in some areas". Now well-established along many roadsides, community and agro-forestry areas. Prevents the regeneration of native species in open or streamside sites.	Too widespread to sustainably reduce infestations. Control to prevent invasion into open areas of high biodiversity value sites. Investigate biocontrol options.	No	Yes
Dayflower (*Commelina diffusa*) WRA score: 23	Established at occasional open, disturbed areas, often near housing or other inhabited areas.	Herbaceous annual or perennial (often perennial in tropical climates). Forms dense patches, rooting at the nodes. Stems to 1 m long. Shallow-rooted.	Recorded on Kosrae since before 2000. Probably spreading via seed or fragments carried by water or machinery movement. Not yet widespread, but	Too widespread to sustainably reduce infestations. Control to prevent invasion into at risk (damp or forest margin) areas of high biodiversity value sites.	No	Yes

Plant species and weed risk assessment scores	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
		Prefers damp and shady areas. Produces seed within a capsule.	well-established. Prevents the regeneration of native species in damp, shady areas.	Investigate biocontrol options.		
Paddle grass (*Ischaemum polystachyum*) WRA score: 20	Very widespread along roadsides, near almost all areas of housing, agro-forestry and other open sites.	Vigorous, sprawling, perennial grass. Roots readily at nodes, upright stems typically to 1.3 m high. Spread via seed or plant fragments.	Present on Kosrae for some decades. Now occupies almost all at-risk sites. Anecdotal evidence that seed or plants transported to Kosrae with cattle brought from Pohnpei. Likely to prevent the regeneration of native species in open, sunny or partially shaded sites.	Difficult to make any sustainable progress in controlling this plant now. Control to protect at-risk (i.e. open sunny areas) high-value biodiversity sites or areas of agro-forestry or gardening that must be free of the plant. Further investigate native range and possible biocontrol options.	No	Yes
Giant bramble (*Rubus moluccanus*) WRA score: not available.	Well-established in forest and forest margins on Kosrae. Few dense patches but often found amongst secondary forest, roadsides in	Scrambling perennial shrub or climber, to 2-3 m high. Stems spiny, rooting where they contact the ground. Red berries,	Recorded as native to Kosrae but uncertainty as to native range. Now occupies all ecologically suitable areas. May form	If possible, the native range needs to be clarified. Control only required in areas where the plant not wanted e.g. garden and agro-forestry	Yes	Yes

Plant species and weed risk assessment scores	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
	forest areas.	bird dispersed seed.	troublesome infestations in some disturbed (e.g. garden areas) locations. Uncertain effects on long-term native regeneration.	areas. If a native plant, then control not required in any native vegetation areas.		
Bottle gourd (*Luffa cylindrica*) WRA score: not available.	Occasionally established, especially in secondary forest, roadside locations in forested areas. Does not seem to be an aggressive invader.	A cucurbit. Climbing herb, assisted by branched tendrils. Leaves to 25 cm long. Yellow flowers and rounded, smooth-skinned fruits, 5-8 cm in length.	Most publications record this plant as introduced to Kosrae; another suggests that it may be native. Uncertain effects on long-term native regeneration.	The identification and native range of the species found on Kosrae needs to be further clarified. Unlikely to require management, except where it is not wanted in garden or agro-forestry areas.	No	Yes

Table 2: Current distribution on Kosrae, description, habitat, ecology, stage of invasiveness, and likely effectiveness of control methods for the other invasive species recorded as present on Kosrae

Plant species	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
Water hyacinth (*Eichhornia crassipes*)	One site in a pond in the Tepat watershed	A free-floating aquatic plant, 0.5 to 1m in height. Forms dense mats. Long, feathery roots. Spreads vegetatively by division or by seed. Seed is long-lived (approx.20 years). Reputation as one of the world's worst aquatic weeds.	Very early stage of invasiveness. Has been present in the pond for approximately 6 years. A survey of down-stream areas of the watershed is required. Hopefully restricted to the one pond. Capable of forming very dense populations, blocking waterways, exacerbating flooding and preventing the regeneration of native species.	Requires an immediate eradication programme. Eradication probably possible.	No	No
Honolulu rose (*Clerodendrum chinense*)	Two known sites in Malem. Approximately 10 to 20 plants.	Sub-shrub to 2 m tall. Fragrant flowers. Spreads via root suckers. Can form dense infestations. Tolerant of shade.	Very early stage of invasiveness. Growing on a stream bank. May spread via broken root fragments carried in stream water. May establish in lowland	Requires an immediate eradication programme. Eradication probably possible.	No	Yes

Plant species	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
			forest preventing the regeneration of native species.			
Lantana (*Lantana camara*)	Has been planted into gardens at commercial sites in Tofol, Finpukal and Utwe. Occasionally found as a pot plant specimen in private gardens.	Vigorous 1.2-2.4 m high, branched shrub. May also grow as a semi-prostrate sub-shrub. Branches have stout prickles. Green berries, black when ripe. Seed distributed by birds.	Early stage of invasion. No naturalised plants seen. Opportunity to prevent the establishment of this very invasive plant. May form dense infestations in sunny or semi-shaded areas, preventing the regeneration of native species.	An awareness campaign and exchange programme (exchange lantana for non-invasive ornamental plants) needs to be implemented as soon as possible. .Prohibit the sale and propagation of lantana. Eradication or control to zero density levels is likely to be possible.	No	Yes
Blue morning glory (*Ipomoea indica*)	Seen at one site at Putuk, southern side of road growing up power pole stays.	Identification should be confirmed by a suitable herbarium. Very vigorous growth. Mature plants prefer full sun. Seedlings shade tolerant. Spreads via seed	Very early. Seed may not have been produced yet on Kosrae. Capable of smothering native shrubs, excluding the light causing death.	Requires an immediate eradication programme. Eradication or infestation reduced to zero density is very possible.	No	No

Plant species	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
		and runners.				
Mission grass (*Pennisetum polystachyon*)	Established over an approximate 300 sq m area, north-eastern end of the road running alongside the airport runway. Some satellite infestations near the airport bridge, Putuk area.	Tufted grass to 2 m tall. Seed head a spike, yellow-brown to 25 cm long. Seed dispersed by wind, water, clothing. Prefers full sunlight situations.	Although present on Kosrae for 12 years or more, evidence seen of recent spread. Likely to become a common weed of roadsides or other open areas. Likely to prevent the regeneration of native species in open habitats.	Still very localised. Opportunity for a control programme to reduce the current infestation to zero density.	No	No
White ginger (*Hedychium coronarium*)	Popular scented garden plant. Herbarium specimen collected from Kosrae in 1958. Seen in many gardens.	Herbaceous perennial to 2 m high. Spreads via rhizomes. Need to establish if viable seed produced by plants in Kosrae. Is shade tolerant and has become a significant problem weed of forests in other Pacific locations.	Problem weed of Hawaii. Likely to spread further on Kosrae, with potential to be a significant weed of forests and stream bank areas, preventing the regeneration of native species in these habitats.	Investigate biocontrol options.	No	Yes
Merremia (*Merremia*	Well-established and	A coarse climbing	Dominates any	Impossible to reduce	Yes	Yes

Plant species	Approximate current Distribution	Description / Habitat / Ecology	Stage and effect of invasiveness	Likely effectiveness of management	Present in the proposed protection area	Present in the Olum watershed
peltata)	very widespread in especially disturbed, lowland forest sites. Dense infestations.	vine with underground tubers. Stems smooth and twine at the tips; they may be up to 20 metres long.	disturbed, lowland forest site. Uncertainty as to true native range and role in succession of forest tree species. Such a dominant plant that further research is required.	infested area by any conventional control programme. Investigate true native range, role in succession of forest trees and possible biocontrol options.		

Kosraean authorities should also investigate the presence, stage of establishment and management options for other invasive plant species (or potentially invasive species) recorded as present on Kosrae. They include Japanese honeysuckle *Lonicera japonica*, recorded as being present in the Tafunsak area; and Purple pseuderanthemum *Pseuderanthemum carruthersii* which was reported to the author as being naturalised in the Utwa area. A precautionary approach is recommended: if infestations of potentially invasive plant species are detected at an early stage of their establishment then, if possible, control them promptly to a zero density infestation level and monitor the site until eradication is achieved. The most positive cost-benefit for invasive plant control is achieved in eradicating an invasive plant species at the very earliest opportunity when control effort and the cost of control are minimal.

4.2 Impacts

Impacts of the ten target species at the proposed protection site, Olum watershed: Currently, there is very little impact from any of the target plant species within the proposed protection area because nine of them are not present. The only target plant found within the protection area was occasional plants of **giant bramble (*Rubus moluccanus*)**. Two seedling plants were located. There were no adverse ecological effects of these plants being within the protection area.

Impacts of the ten target species within the Olum watershed excluding the proposed protection area:

Bronze-leaved clerodendrum (*Clerodendrum quadriloculare*): Not present.

Leucaena (*Leucaena leucocephala*): Not present.

Mile-a-minute (*Mikania micrantha*): Not present.

Siam weed (*Chromolaena odorata*): Scattered infestations of Siam weed are established 1 km eastward of the proposed protection area near housing in Malem village. The infestations are found over an area of approximately 4 ha and occupy abandoned areas near stream and forest margins. Machinery such as road graders have exacerbated the spread of Siam weed along roadsides. Currently the infestations do not prevent access to forest, agro-forest or garden areas. Siam weed has been known to cause skin complaints and asthma in allergy-prone people. Within the Olum watershed, Siam weed currently has a minor impact on biodiversity, economic, social and health values. Left uncontrolled, these effects could become of concern. Siam weed does not readily establish or set seed beneath an intact forest canopy. It does not, therefore, present a significant threat to the proposed protection area in the Olum watershed.

American joint vetch (*Aeschynomene americana*): One infestation of approximately 10 square metres is established along the Malem – Itut roadside, approximately 1 km from the proposed protection area. The infestation is occasionally mown and rarely grows to more than 1 m height. The amount of viable seed produced is unknown. American joint vetch may slowly spread along the roadside to the upper valley. It grows best in full sunlight and has been described as “essentially a wetland plant”, establishing in sites such as drainage ditches. American joint vetch is a nitrogen-fixing plant. Long term effects on the regeneration of native plants are unknown. Effects on biodiversity, economic, social and human health is likely to be minor. American joint vetch is not likely to be a significant threat to the proposed protection area.

Wedelia (*Sphagneticola trilobata*): Scattered infestations are established along the Malem-Itut roadsides and banks of the Olum stream, becoming less-frequent in the upper valley. A small 2 square metre infestation exists in the landowner's garden, 100 metres from the proposed protection area. Some infestations are regularly mown. Wedelia is a dense ground-cover species, preventing regeneration of native plants. It has a wide ecological tolerance range, grows best in sunny sites but will survive in shady areas. It is a nuisance plant in gardens and so does have minor economic effects. Wedelia produces few fertile seeds. As machinery is not used within the protection area, there is low risk of plant fragments being carried into it.

Dayflower (*Commelina diffusa*): There is a small, 5 square metre infestation near the landowner's house, 100 metres from the proposed protection area. Occasional infestations of dayflower are established near housing along the Malem-Itut road, typically in damp, partially shaded locations. The average size of these infestations is approximately 15 square metres. Beside the plants growing near the landowner's house, the closest infestation is 500 metres from the protection area. Dayflower does form a dense groundcover and will prevent the regeneration of some native species that prefer damp, shady environments. Dayflower has been used as a medicinal plant and so may have some positive health value. Its effect on biodiversity values in the Olum watershed is currently minor. Dayflower is not a major weed of gardening or agro-forestry. Economic and social effects are minor. There is a low to moderate risk that dayflower may infest the protection area. It should be controlled at especially the landowner's house site to reduce this risk.

Paddle grass (*Ischaemum polystachyum*): Well established within the landowner's agro-forestry adjacent to the proposed protection area and along the Olum Stream valley to the sea. Paddle grass is less prevalent in any shady areas. It has been controlled by cutting with a machete or mechanically by mowing or weed whacker. This grass species is recorded as a prolific seed producer and now occupies almost every site likely to be infested on Kosrae. Although paddle grass grows in the partial shade of agro-forestry areas it is not particularly shade tolerant and does not establish beneath an intact forest canopy. It is not likely to infest the proposed protection area. Paddle grass has moderate economic effects in that it is a fast-growing grass species requiring regular control to ensure that access is maintained around, for example, housing and agro-forestry areas. It requires regular control within any gardened area. At many sites it forms a dense ground cover and probably assists in preventing more invasive shrubby weeds from establishing. There is uncertainty as to whether it is a native plant or exotic introduction to Kosrae. Its native range needs to be clarified before effect on biodiversity values can be estimated.

Bottle gourd (*Luffa cylindrica*): Currently bottle gourd does not infest the proposed protection area, but is found in the agro-forestry area adjacent to the landowner's house. It is a shade tolerant plant. Bottle gourd is most widely regarded as a native species to Kosrae, but it may be an early introduction. . Bottle gourd has some medicinal value. It has been recorded as being occasionally heavily attacked by the cucumber beetle (*Aulocophora quadrimaculata*) which may have a biological control effect in reducing the reproductive and growth vigour of bottle gourd. The landowner occasionally controls the bottle gourd growing near his house, as he doesn't like the prickly stems from becoming too prevalent. All control is by hand with roots being dug up and the plant left to dry and later burned. Bottle gourd has minor biodiversity, economic and social effects. It does not present any significant threat to the protection area.

Giant bramble (*Rubus moluccanus*): Occasional giant bramble plants are likely to be growing outside of the proposed protection area and elsewhere within the Olum watershed. No plants were found during the field site visits. The native range of giant bramble needs to be defined. From observation during the site visits for this feasibility study, giant bramble was a "nuisance plant" and was not seen to occupy extensive areas. It is controlled in gardens, agro-forestry, or when growing close to housing areas. It is unlikely to increase in density within the watershed unless mature giant bramble infestations are left unmanaged and act as a seed-source infesting adjacent unmanaged areas. It may need to be controlled if that occurs so that incursion into the protection area is reduced through possible bird-borne seed distribution. Giant bramble appears to have minor biodiversity, economic and social effects. There may be some negative health effects from the prickly canes. This may be off-set by the edible fruit. Currently, giant bramble does not present any significant effect to the proposed protection area.

Impacts of the other invasive species recorded on Kosrae within the Olum watershed:

Honolulu rose (*Clerodendrum chinense*): Two small infestations, each being less than 10 plants, are established within the watershed. One is approximately 800 metres from the proposed protection area, near housing and between the road and the Olum Stream. A landowner planted the Honolulu rose as an attractive ornamental plant. One plant was flowering. Plants did not yet look to be naturalised, i.e. self-spreading. The plants were obtained from another gardener in the watershed that lives near the northern end of the Malem municipality. Honolulu rose was being grown at this site, approximately 1.5 km from the protection area, as an ornamental plant. It is not known whether plants have set seed at either site. The Kosrae Department of Resources and Economic Affairs intend to control the plants as soon as possible and eradicate Honolulu rose from the island. Honolulu rose is shade tolerant, will establish beneath lowland forest trees, will disrupt native plant regeneration and does present a threat to the protection area. Left uncontrolled, it is likely to become a well-established invasive plant. It may become a serious weed of agro-forestry or gardened areas. Potential economic impact may be moderate; effects on biodiversity values may be moderate to high. Social and health effects are likely to be minor. All Honolulu rose plants should be immediately controlled as part of an eradication programme.

Lantana (*Lantana camara*): Two lantana plants were observed in gardens in the Malem municipality; one as a pot plant and the other as an ornamental garden plant. Both plants were flowering (orange / yellow) but no fruits were observed. If lantana was to naturalise in Olum watershed it is likely to eventually disrupt access to agro-forestry or garden areas and potentially access to the proposed protection area. It will grow in full light and partial shade and if well established, would prevent some native plant regeneration. Lantana is a poisonous plant with thorny stems. If it were to establish, it may have a moderate impact on biodiversity values; a minor economic impact through disrupting access to areas people frequent; minor to moderate health impacts and minor social impact. Lantana plants should be immediately controlled before naturalisation occurs in the Olum watershed. Lantana could establish beneath the forest canopy of the protection area, although plants in that habitat are unlikely to flower and fruit.

White ginger (*Hedychium coronarium*): White ginger is a popular ornamental plant and can readily be seen growing near dwellings in the Malem municipality. Research should be undertaken to see if viable seed is produced and to what extent naturalisation has occurred. *Hedychium spp*. have the potential to infest areas of full shade, i.e. beneath an intact forest canopy, so that it may be a future threat to biodiversity values within the proposed protection area. Biodiversity and economic impacts are currently low. The health impact of white ginger plant is low. Long-term, biological control may be an option in assisting with the control of this plant.

Merremia (*Merremia peltata*): Merremia is well-established in the lowland, disturbed forest areas of the Olum watershed. If the true native range of Merremia can be established, then its status as a native or introduced invasive plant can be clarified. Merremia is present within the proposed protection area but does not currently have a significant damaging effect on the forest canopy. It may not increase within the protection area as the forest has an established canopy and few light wells allowing Merremia plants to grow rapidly. It may, however, spread from the disturbed forest on the margins of the protection area and eventually smother mature forest within it. Merremia, if an exotic invasive, is a moderate threat to the biodiversity values of the protection area. If the forest were to be heavily infested by Merremia, there could be a negative effect on eco-tourism and therefore a moderate economic and social effect.

4.3 Benefits of management

The proposed protection area is an ecologically outstanding example of undisturbed lowland forest on Kosrae. It contains an excellent range of native and endemic flora and fauna and, apart from giant bramble, is relatively free of exotic invasive plants.

The benefits of good management will ensure continuing eco-tourism and visits from, for example, school groups, to experience the biodiversity values of this area of forest and the historical features within it. There will be an on-going economic benefit to the protection area's landowners and others in the community (e.g. shop keepers) if eco-tourism continues in the proposed protection area.

Controlling invasive plants which threaten the biodiversity and water catchment values of the proposed protection area will ensure that those positive values are retained.

Invasive plant management includes controlling any invasive plants which encroach or establish within the protection area, and those that are established in the vicinity and likely to be vectored into it.

5 CAN IT BE DONE?

5.1 Technical approach

There is a significant variation in the distribution, density, stage of invasiveness and environmental effects of each of the specified target plant species on Kosrae. Most of the 10 specified target plant species have established beyond the point of making sustainable progress in reducing infestations on Kosrae island through on-going methodical and effective control programmes. Two plants; bronze-leaved clerodendrum and leucaena, can be reduced to a zero density level if an effective, on-going control programme is implemented. Mile-a-minute may be contained to the currently infested north western area of the island with a vigilant surveillance and controlling satellite

populations approach. Siam weed, American joint vetch, Wedelia, dayflower, paddle grass, giant bramble and bottle gourd are well established over significant areas and should be controlled to protect high-value biodiversity areas, or gardens and agro-forestry areas where they have a negative effect.

Herbicides are seldom used on Kosrae. Most people would rather hand weed invasive plants than use herbicides and risk personal injury or damage to the environment. However, the two herbicides used by Kosraean authorities to control invasive plants are those with the active ingredients *Glyphosate* and *Triclopyr.* The herbicide application method most commonly used is the stump treatment method applied to the stumps of woody invasive plants. Results from this method have been erratic, mostly because of the regular daily rainfall washing the herbicide from the target plant and poor application technique.

For the stump treatment method: the trunk should be cut within 5 to 10 cm of ground level, in a horizontal manner, and the herbicide mixture applied to the top and sides of the cut stump. Care has to be taken to apply herbicide as soon as possible after cutting the stump, to maximise absorption and to minimise run-off of herbicide.

Those applying herbicides need to be up-skilled in their use. Kosraean authorities should consider obtaining and trialling additional herbicides. Herbicides with the active ingredients *Metsulfuron-methyl, Fluroxypyr* and *Clopyralid* may be very useful in effectively controlling target species or new-incursion low incidence invasive plants in a variety of situations. *Clopyralid* can be used selectively over shrubs or trees to control some species of invasive climbers. *Fluroxypyr* is registered in Australia and New Zealand for the selective control of a wide range of broad-leaf weeds including woody weeds. Application methods for *Fluroxypyr* include target-specific options such as basal bark and cut stump but there are restrictions on the use of this herbicide near streams. *Metsulfuron-methyl* is used in Australia to control Wedelia and in New Zealand to control *Hedychium* species. Other effective and environmentally acceptable herbicides should also be considered.

The herbicide applicators must be appropriately qualified and use personal protective equipment. Herbicides and application tools / gear need to be safely stored and transported.

The native range of some of the invasive plant species needs to be further researched. This should be undertaken for paddle grass, giant bramble, bottle gourd and Merremia. This will clarify as to whether they are native or exotic and so, whether options such as biological control can be further explored (biological control research may be undertaken for exotic, invasive species; it is generally not appropriate to introduce biocontrol agents into a plant's native range area).

Biological control options should be researched for mile-a-minute, Siam weed, Wedelia, dayflower and probably white ginger. The Secretariat of the Pacific Community (SPC) and New Zealand's Landcare Research are aware of the status of biocontrol programmes for some of these plant species. Some research and biocontrol agent release programmes are now well advanced. Kosrae should provide funding and active collaboration toward a Micronesian or wider Pacific programme to advance the biological control options of especially well-established exotic weeds. Effective biological control programmes may assist with long-term control of plant species.

Priority actions to prevent invasive plants infesting the proposed protection area in the Olum watershed are:

1. Control the two new incursion invasive plants that are present in very low populations. All Honolulu rose and lantana plants within the Olum catchment should be destroyed as soon as possible. It is possible to hand dig the plants at each site and this is the preferred control method. An alternative is to stump treat the larger plants, basal diameter 5 cm or larger, and dig out smaller plants. Suitable herbicide and application technique is to use a mixture of 1 part *Glyphosate* to 5 parts water applied to the top and sides of the cut stump. The herbicide mixture must also be applied to any exposed roots of these plants.

2. Control the only target invasive plant, giant bramble (*Rubus moluccanus*), within the proposed protection area. Seedling plants are easily controlled by pulling or digging from the ground, removing all soil and leaving to dry. Ensure that all roots are off the ground so that re-rooting does not occur. This is best achieved by hanging the plant in a nearby fork of a tree or shrub. The only giant bramble plants found within the protection area were seedling plants.

3. Control target plants which are a threat to biodiversity values within the proposed protection area.

   a). Wedelia and dayflower can be controlled by digging the Wedelia and carefully shaking all soil from plant roots. Dayflower can be hand pulled and soil removed from the roots. Plants should be left to dry out in an area such as a garage or shed with a clear floor space. The plants can be burnt when completely dry.

   b). Control any bottle gourd plants by digging from the ground and left to dry. Fruits should be gathered, dried and burnt to reduce risk of seed germinating and plants re-establishing or seed being vectored into the protection area.

   c). Paddle grass within the agro-forest area adjacent to the landowners dwelling should be mown or slashed to maintain control, prevent seeding and allow continued access into the protection area.

   d). Siam weed, American joint vetch, dayflower, giant bramble, bottle gourd and remaining Wedelia infestations within the Olum watershed should be managed through a combination of community programme, professional assistance with for example, stump treating plants, and best practice to prevent machinery, such as road graders moving the target plants along the road corridor and closer to the proposed protection area. A community control programme should be implemented so that landowners are aware of the target and new incursion plant species and can assist in preventing their further spread, especially toward any protection areas in the upper watershed. Effective organic control methods can be publicised and landowners encouraged to help in reducing infestations. Control methods can include hand weeding and digging. Funding should be available to assist landowners with “more difficult to control” weeds such as Siam weed. If landowners are agreeable, they could possibly enlist the assistance of a professional to apply herbicide to the target plant

e.g. cut stump method for Siam weed using 1:5 *Glyphosate* mixture. This work needs to be funded and undertaken by a suitably qualified professional.

e). The density and distribution of the target and low-incidence plant species within the watershed should be monitored and recorded at approximately 6 month intervals.

f). Dumping of garden rubbish (into especially the upper watershed) should be prohibited.

g). Any roadside mowing undertaken through the roadside maintenance programme should start from the upper catchment (near the road end and protection area) and proceed toward Malem Township. This would minimise the risk of the mower moving invasive plant seeds or fragments into the upper catchment closer to the proposed protection area.

h). Biosecurity best-practice procedures should be followed by all people entering the proposed protection area to ensure that invasive plant seeds or fragments are not inadvertently carried into the area.

5.2 Sustainable

Maintaining the proposed protection area within the Olum watershed free of invasive plants is sustainable as long as:

- Regular surveillance for re-invasion and new incursions occurs.
- Invasive species that could survive in the shade of the lowland forest canopy are not allowed to establish within close proximity to the protection area, so that they can naturally invade or be otherwise vectored into the area.

Table 3: Invasive Pathways for the ten specified target species into the proposed protection area:

Target Invasive Species	**Source**	**Pathway**	**Risk**	**Prevention Strategy**
Species Name	*Where will the invasive species come from*	*How will it travel to the project site?*	*How severe is the risk:*	*How will you prevent the species using the pathway to invade*
Bronze-leaved clerodendrum	Infestation 1.5 km south	Bird-borne seed	Low /Medium	Eradication programme must be implemented for this species on Kosrae
Leucaena	Infestation 3 km northward	Contaminated machinery used on roadsides	Low	Eradication programme must be implemented for this species on Kosrae
Mile-a-minute	Infestations 7 km northward	Wind-borne seed / machinery / seed on clothing	Medium	Surveillance programme to identify and control any satellite infestations in the Olum watershed
Siam weed	Infestations 1 km eastward	Wind-borne seed / machinery / seed on clothing	Low	Surveillance and community control programme to prevent infestations establishing within 1 km
American joint vetch	Roadside infestation 1 km eastward	Roadside machinery	Low	Control the small infestation.

Wedelia		Dumped garden rubbish. Root fragments on tools such as a spade	Medium	Remove from the landowner's garden as soon as possible. Have any roadside mowing or construction machinery proceed from the top of the watershed toward the Malem township
Dayflower	Landowners house and scattered infestations within the Olum watershed	Dumped garden rubbish. Root fragments on tools such as a spade	Medium	Remove from the landowner's garden as soon as possible. Have any roadside mowing or construction machinery proceed from the top of the watershed toward the Malem township
Paddle grass	Landowners agro-forestry area	Unlikely to establish in heavily shaded areas but seed or fragments could be vectored into the protection area on clothing or planting gear.	Low	Continue to mow and slash as a precaution
Bottle gourd	Landowners agro-forestry area	Bird-borne seed	Medium	Remove from the landowner's agro-forestry area as soon as possible.
Giant bramble	Landowners agro-forestry area	Bird-borne seed	Medium	Remove from the landowner's agro-forestry area as soon as possible.

5.3 Socially acceptable

The Protecting Kosrae's Upland Forest project has been well-planned and is well-supported by the community. The following has been contributed by KCSO:

"The initial stage of the project was to consult with leaders and members of the community. On the 16th of January, 2012, KCSO's Executive Director, Mr Andy George, and project managers met with the Mayor, municipal leaders, community members and landowners of the proposed protection area in Malem municipality. The purpose of the meeting was to garner leadership and community support before any implementation takes place. Invasive species does have an impact on food security; therefore the concept of invasive management is fully supported by most farmers in Kosrae. The agencies mandated to control such species are the Kosrae Island Resource Management Authority (KIRMA) and Department of Resource and Economic Affairs (DREA). Both were counterparts with Kosrae Conservation and Safety Organization (KCSO), especially when implementing outreach awareness and small scale on-the ground projects. KCSO has built a strong partnership with the Department of Education (DOE) where we usually disseminate awareness information throughout the schools in Kosrae. The Kosrae Women Association (KWA) has always been involved during workshops and community awareness outreach. They are also very active with reforestation projects coordinated by KIRMA and DREA as well as assisting the community awareness on resource conservation efforts in Kosrae. Their involvement will also be a perfect tool for disseminating facts and risks of cultivating alien invasive ornamental species on Kosrae. An awareness program has been conducted in schools and community where discussions and

environmental games were presented on the risk of invasive species outbreak in Kosrae. Currently, we have encountered community people and especially ornamental gardeners who have not known the potential risk of their attractive collection of ornamental species brought into Kosrae".

Many positive comments were conveyed to the author during the Feasibility Study field trip. A meeting was held at the Department of Resource and Economic Affairs (DREA), 17 July 2012, and attended by representatives of the community and government departments. Besides DREA, representatives of Kosrae Island Resource Management Authority (KIRMA), forestry, quarantine, the Olum and Utwe Municipalities and the Pacific Adaptation to Climate Change programme attended. There was unequivocal support for the Protecting Kosrae's Upland Forest project and desire to receive further advice regarding the management of invasive species.

A further two community meetings have been undertaken by KCSO in Malem village since the authors visit as part of this Feasibility Study. A 20 August 2012 meeting focused on assessing threats to the environment including invasive plants. 27 people attended the workshop. A group discussion followed the presentation from KCSO. The community voiced a desire to be involved in the long-term management of invasive plants within the wider Olum watershed. A further workshop was held 27 August 2012 and attended by 40 participants. This workshop, also run by KCSO, included discussion on the vision and objectives for the Olum watershed. The community again expressed a desire to be involved in the long-term management of the proposed Olum watershed protected area (L Sanney – personal comment).

Care will need to be exercised, in controlling any invasive plants within the Olum Watershed or wider Kosrae island, where landowners are agreeable to the use of herbicides on their property. There is a strong "organic" ethic on Kosrae, in that there is very little use of any herbicides. Government authorities are the main users of herbicides and these are mostly applied with the stump treatment method. Herbicides are expensive on Kosrae which contributes to the low use. People are wary of the health and environmental effects of any pesticide and therefore organic control methods are preferred.

Invasive plant control should prioritise organic methods as long as they are effective. Herbicides, when applied, need to be applied by trained operators and used prudently, i.e. stump treatment or the direct injection method used if possible, rather than overall or gun and hose application method.

Signage should be used, as per best-practice guidelines, if any spray application of herbicide is undertaken.

Table 4: Key Stakeholders Identified so far

Name	**Affiliation** (e.g. agency, community, youth group etc)	**Contact details**	**Project interest**	**Notes/comments**
Jason Jack	DREA	jhjack@gmail.com	Invasive Coordinator	Expertise in control and eradication management is well suited for the project
Leon Sigrah	KIRMA	leonsigrah@yahoo.com	Invasive Coordinator	Expertise in control and eradication management

				is well suited for the project. Works under Forestry and Wildlife.
Carlos Cianchini	PACC Project	cjcianchini@yahoo.com	Climate change awareness coordinator	An expatriate and is very willing to support implementation of the project
Hamilson Phillip	Olum Family Organization	N/A	Owner of the proposed protection area.	Very supportive and understanding.

5.4 Politically and legally acceptable

The Federated States of Micronesia (FSM) National Biodiversity Strategy and Action Plan (NBSAP) was endorsed 13 March 2002. The NBSAP includes policy on invasive plant control. The introduction section clarifies legislative responsibilities and specifies that individual States within the FSM are to address issues relating to the Strategy:

The legislation and institutional framework of the Federated States of Micronesia includes, both National and individual State constitutions with each of the four States functioning as semi-autonomous governments. This structure makes it a prerogative of each State to enact their own legislation in line with their powers as mentioned in the FSM Constitution to address all issues relating to the conservation of biodiversity. Therefore, the responsibility for the implementation and monitoring programs of the NBSAP is to be undertaken by the individual States, not the National government.

Further, under 10.6, Theme 6. Biosecurity, p34:

Objective 2: Control and Eradication: *To identify and develop appropriate programs to ensure effective control and eradication of species threatening biodiversity.*
Actions: (in part)

Develop programs for the control and eradication (where feasible) of invasive species.

Organize an invasive species task force and develop rapid response plans in each State.

And p35 of the NBSAP:

Objective 3: Research & Monitoring: *To undertake a systematic and scientific research monitoring program to allow management of biosecurity threats.*

Actions:

Review, evaluate, update and prioritize the lists of terrestrial and aquatic invasive species in the FSM.

Strengthen the National and State government agencies to be able to undertake appropriate scientific research and assessment of introduced species.

Increase collaboration with regional and international agencies to assist in the identification, control and eradication of invasive species.

Kosrae State has the authority to develop a State Strategy to manage invasive species threatening biodiversity values.

There is currently a collaborative approach to invasive species management on Kosrae with regular dialogue between Government departments and NGOs such as the KCSO. There are also proposals to enlist the assistance of NGOs in managing invasive species.

This section contributed by KCSO:

There is no greater threat to island biodiversity and its resources than the spread of unwanted plants and animals, pests and diseases onto our island. In confronting this threat, one of our most urgent tasks is to assist partner governments to develop the multiple means of effective border control. Without such capabilities, this island is simply not in a position to secure its borders against the transit of these pests or other products and material they may infest.

The invasive species unit (ISU) under the Department of Resources and Economic Affairs (DREA) draws on the expertise and cooperation of a range of KSG agencies and NGO's to provide assistance and means of control, along with the necessary information and equipment, to put the relevant capabilities into the hands of border control and inspection authorities.

The current Micronesia Bio-security Plan (MBP) directs enhanced assistance to strengthen efforts to prevent the introduction and further spread of invasives including injurious insects, pests, and diseases into and within the Micronesia region (Kosrae Comprehensive Procedure on Border Control and Inspection-CPBC/DREA).

In the absence of a current invasive species management strategy (or plan) with rules and obligations clearly defined, authorities will need to seek consent from private landowners to enter their land for surveillance and monitoring work, as well as subsequent control or eradication which may include herbicide use.

Ultimately, Kosrae State needs a specific National Invasive Species Action Plan, defining species to be managed, the management approach for each species, funding, responsibilities and rules.

A well planned community-led approach can work effectively if the invasive species management programme has the support of all the community. This is especially important in achieving Objective 2 of the project, where the community will be actively managing invasive species within the wider Olum watershed, which includes most of Malem village. There appears to be a high level of support in the Malem Municipality to protect biodiversity and water supply values within the Olum watershed, so that the recommended management actions for invasive species identified in this report should be achievable.

5.5 Environmentally acceptable

This project will have a net positive effect in that invasive species are removed from the environment, there is not likely to be any residual effects from herbicide applications and the potential threat from the invasives to the proposed protection area is minimised or removed.

If CEPF continues to support this project and herbicides are intended to be used (rather than solely organic invasive plant management methods), then KCSO will need to complete a Pest Management Plan using the guidelines from the World Bank. The Guidelines are in Appendix 6.

Methods ensuring that there is no negative environmental effect for each of the management areas include:

For the proposed protection area: The proposed protection area is practically free of the specified target invasive plant species (apart from seedlings of giant bramble, *Rubus moluccanus*) and the other invasive species present in the Olum watershed. Giant bramble plants can be controlled without using herbicide. There is no detrimental effect to soil or plants from digging out giant bramble.

However, a potential positive effect of the giant bramble should be further researched: it may provide a valuable food supply to the endemic "Tuhram" Kosrae white-eye (*Zosterops cinereus*). The true native range of giant bramble needs to be defined (as mentioned in section 4.2 Impacts). If it is considered a native plant to Kosrae and is a food source to the Kosrae white-eye, then giant bramble may not need to be controlled at the proposed protection site. There was no evidence of it crowding out native species in the proposed protection area.

Some native tree species are being planted in the proposed protection area to increase the biodiversity value of the site, provide a food source to native fauna and ensure the survival of rare species.

For the land-owners' property adjacent to the proposed protection area: The landowners prefer organic management methods on their property. Recommended methods to control wedelia, dayflower, bottle gourd and paddle grass on the landowner's property near the protection site would not include the use of any herbicide. There is no detrimental environmental effect from the hand control methods recommended.

For the other invasive species in the Olum watershed: Control of the lantana and Honolulu rose infestations should also be achieved through hand control methods: either digging all plants from the infested sites or a combination of digging seedlings and applying a minimal amount of herbicide to the cut stumps of plants over 5 cm basal diameter. Landowners should be offered in exchange a suitable non-invasive ornamental or native plant to replace the invasives.

Ensuring that management of all other specified target or other invasive plant species in the Olum watershed is undertaken through a Community Control Programme should minimise risks to the environment. Landowners will hopefully understand the detrimental impacts of the invasive species, will assist in their management by methods such as hand removal, allow the use of *Glyphosate* herbicide as a stump treatment method to Siam weed, and help prevent the weed from re-establishing. The herbicide would be applied by a qualified professional using an appropriate application method, such as a trigger bottle sprayer or low-pressure knapsack application. There will be no residual effects to the soil.

Grass species (a probable mixture of native and exotic) are established near all of the infested sites and are likely to re-establish once the invasives are removed. A future trial project could include over-sowing an environmentally acceptable grass species at sites where invasives are removed and

bare soil is exposed. The grass would form a ground cover and prevent further invasive plants from establishing.

5.6 Capacity

For the proposed protection area: All skills are locally available. The landowner can control the giant bramble and continue to survey for any new incursion invasive plants (if it is decided to remove the bramble, rather than leave for native species to feed on). Members of KCSO are skilled in identifying native and exotic plants and can assist with surveying for new incursion invasives.

For other invasive plant species within the Olum watershed: Members of KCSO and Kosraean Government agencies have many of the skills required to oversee management of invasive plant species in the watershed. Plant species can be correctly identified and proficiently removed by digging or other physical means. Further training is required to increase proficiency in control methods using herbicides, such as cut stump, direct injection and application of herbicide with knapsack or machinery such as C-DAX or gun and hose units. Herbicide applicators also need to be suitably qualified and skilled in using personal protective equipment, such as gloves, footwear and respiratory gear.

For the management of invasive plant species on Kosrae: Members of KCSO and Kosraean Government agencies need to be upskilled in developing and using an efficient system to correctly identify suspected invasive plants and determine best management approach. It is critical that any new incursions of invasive plants are identified and managed while it is cost-effective. Comments regarding herbicide application training above are applicable.

Training or mentoring may be required in developing a national invasive species action plan. This includes components of the plan such as determining priority species, different management approaches, simple cost-benefit analysis, increasing public awareness of invasive species and developing community control programmes.

Availability of Team Leadership: KCSO, assisted by Kosraean authorities, have been pro-active in advancing formal protection for areas of the Olum watershed. KCSO has the capacity to provide leadership in the field to oversee, coordinate and where appropriate assist in the management of invasive plants to protect the proposed protection area. KCSO intends to make funding applications, including for further training, to undertake this work.

Table 5: Key Skills needed to complete the project within the proposed protection area and management of invasive plant species within the Olum watershed and elsewhere on Kosrae

KEY SKILL	PURPOSE	METHOD TO OBTAIN SKILLS
Research	To determine best-practice management methods for established and new-incursion invasive plants.	Mentoring from, and collaboration with, agencies advising or undertaking management of these species in other tropical locations. Use of web-based information sources e.g. PIER, ISSG, etc.
Planning	To develop a National Invasive Species Action Plan (NISAP). To develop species management plans. To develop long term management of the proposed protection area.	Mentoring from, and collaboration with, agencies advising or assisting in the development of NISAPs, species management plans and "high-value biodiversity area" management plans.
Report writing	1). Accurate accounts of what was achieved to demonstrate to stakeholders. 2). Document lessons learnt to benefit other projects. 3). Prepare high-level reports on effectiveness of NISAPs and management plans.	1 and 2 are available through KCSO. 3 through mentoring from agencies advising or assisting in the development of NISAPs, species management plans and "high-value biodiversity area" management plans.
GIS / GPS / Database monitoring of progress	To accurately record the location of invasive pests, monitor progress and implement a system of scheduled monitoring and surveillance.	GIS and GPS skills are available through KCSO and other departments in Kosrae. Database monitoring programme needs to be obtained from a mentoring or other agency.
Planting	To replace invasive species with appropriate native plants.	For tree species KCSO. For grass species to oversow control sites, through Government agencies in Kosrae.
Invasive plant identification	Sound biosecurity surveillance and targeting the right plants.	KCSO and Kosraean agencies skills are developed for common species. Mentoring to ensure that efficient use is made of the internet, herbaria and advisory network.
Health and safety	Maintaining safe work environment.	KCSO and other agencies for hand control techniques. A formal training course required for herbicide application requirements.
Invasive plant control methods	Appropriate and effective hand, mechanical or herbicide control methods are used.	KCSO and other Kosraean agencies for most hand control techniques. A formal training course required for knapsack and motorised herbicide application techniques.

Table 6: Human Resources Skills Register

This table clarifies the skills required of a project leader and project team member to complete the project.

SKILLS REQUIRED	STAFF Role: Project leader	STAFF Role: Project team member	
Research	Yes	Yes (assist)	
Planning	Yes	Yes (assist)	
Report writing	Yes	Yes (gather info)	
GIS / GPS / Database	Yes	Yes	
Planting	No	Yes (working with the	

		landowner and community members)	
Invasive plant identification	Yes	Yes	
Health and safety	Yes	Yes	
Invasive plant control methods	Yes	Yes	
EXPERIENCE (YEARS)	5	2	
HIGHEST EDUCATION	Tertiary	Tertiary	

5.7 Affordability

Table 7: Indicative Cost: Management of invasive plants within the proposed protection area and the Olum watershed (costs in US dollars)

Item	Details	Cost (US$)
Project Design Stage		
Project design report	80 hours labour (for planning, investigation, consultation, etc.)	2,400
A. Project Design Stage, Expected cost		**2,400**
Operational Planning Stage:		
Operational plan compilation	120 hours labour (Planning, further community consultation re the concept, advice and mentoring)	3,600
Training in herbicide application techniques and certification	Trainer travel to Kosrae for a 3 day course from Pohnpei or Guam.	5,000
Operational Planning Stage, Sub-total		8,600
Operational Planning Stage, Contingency (10%)		860
B. Operational Planning Stage, Expected cost		**9,460**
Implementation Stage: Year 1		
Control work within the proposed protection area	Remove giant bramble (survey entire 3.3 ha area and dig out plants + surveillance in Yr. 1) 120 hours x $10 / hr.	1,200:00
Control work for invasive plants in the remainder of the Olum watershed (initial control + follow-up over 1 year)	Wedelia, dayflower, bottle gourd, paddle grass at the landowner's property (120 hrs.); Lantana (52 hrs.), Honolulu rose (60 hrs.), treat Siam weed (640 hrs.). TOTAL = 872 hours x $10 / hr.	8,720
Awareness programme + materials (factsheets / posters)	200 hrs. x $10 / hr. + $500 materials	2,500
Expert advisor to the Community Control Programme (upskilling landowners, promoting best-practice)	160 hrs. x $12:00 / hr.	1,920
Implementation Stage, Sub-total		14,340
Implementation Stage, Contingency (20%)		2,868
C. Implementation Stage, Expected cost		**17,208**

Sustaining the Project Stage: Years 2-5		
Control work within the proposed protection area	Surveillance for giant bramble + other new-incursion pests) 80 hrs. / yr. x $10/hr. x 4 yrs.	3,200
Control work for invasive plants in the remainder of the Olum watershed	Surveillance at the landowners property and continue suppression of paddle grass allowing access to the proposed protection area (108 hrs. / yr. x 4); lantana and Honolulu rose (96 hrs. / yr. x 4); follow-up treatment of Siam weed (160 hrs. / yr. x 4 yrs.) x $10 / hr.	14,560
Awareness programme + materials (factsheets / posters)	40 hrs. x 4 yrs. x $10 / hr. + $300 / yr. x 4	2,800
Expert advisor to the Community Control Programme (upskilling landowners, promoting best-practice)	80 hrs. x 4 yrs. x $12 / hr.	3,840
Sustaining the project cost Years 2-4		24,400
20% Contingency		4,880
D. Total Sustaining the Project Stage, Expected years 2 -5 cost		**29,280**
Project Design Stage, Expected cost (A)		2,400
Operational Planning Stage, Expected cost (B)		9,460
Implementation Stage, Expected cost (C)		17,208
Sustaining the Project Stage (D)		29,280
PROJECT TOTAL		**58,348**

6 CONCLUSION

Regarding Objective 1 of the project (*For the proposed protection area within the Olum watershed: Target invasive plant species are managed preventing them from infesting the protection area.*):

The management of invasive plant species within the proposed protection area is likely to be successful. It is currently only lightly infested with one of the specified invasive plant species. This species is relatively easy to control. Reduction to zero density is achievable.

Regarding Objective 2 of the project (*For the Olum watershed: Management recommendations are provided for the target invasive plant species*):

Invasive plant threats to the proposed protection area should also be relatively easy to manage. Four of the specified target invasive plant species are established at the landowner's property in close proximity but can be easily hand-weeded or in the case of paddle grass, unlikely to establish in the low light levels of the native forest. Other invasive plant threats elsewhere within the watershed are either at a very low incidence and can be eradicated or reduced to zero density; unlikely to establish within the very low light levels of the native forest in the proposed protection area; or can be restricted in their distribution through a combination of a community programme and

professional assistance. **Specific management recommendations for the target invasive plant species are listed in 5.1 Technical Approach. This meets Objective 2 of the project.**

It is imperative that Kosraean authorities control the new incursion and low-incidence invasive plants Honolulu rose (*Clerodendrum chinense*) and lantana (*Lantana camara*) before they naturalise into the Olum watershed.

A successful community programme, with professional assistance to successfully control woody species such as Siam weed (*Chromolaena odorata*), is essential in preventing the spread of these species toward the proposed protection area. Some of these species may establish within the forest margins.

It is essential that Kosraean authorities support research that helps determine the status of species as native or introduced where uncertainty exists for these invasive plants.

KCSO, working collaboratively with Kosraean government agencies, is capable of coordinating and undertaking the project.

Project costs are reasonable: $2,400 to design the project; $9,460 to complete the operational planning stage; $17,208 to implement the project in year 1; $29,280 to sustain the project over the next 4 years and a Total Project Cost over 5 years of $58,348.

This total cost will ensure that the proposed protection area remains free of the identified invasive plant species for at least 5 years after implementation. An evaluation of the project should be undertaken in the fifth year and decision made on whether to proceed and to what extent.

The expected benefits of the project include:

- Protection of a high quality and rare lowland forest
- The Malem community is more likely to secure a high quality water supply unaffected by siltation exacerbated through the effects of invasive plants
- Eco-tourism can continue through a lowland forest area – the area is accessible and not degraded by invasive plants
- School groups can continue to observe a high quality lowland forest free of invasive plant species
- Kosraean authorities and people will be more likely to protect other high quality forested areas after observing a successful project within the Olum watershed
- Some invasive plant species are destroyed before they establish on Kosrae or within the Olum watershed.

Objectives 3 and 4 of the project concern the survey, recording of distribution and recommending management options for target and other invasive plant species on Kosrae island. Field work for this Feasibility Study has contributed to achieving these objectives, but on-going regular surveys, recording of data and research are required for their completion. These objectives are feasible as long as the training at Objective 5 is obtained.

Objective 5 concerns recommendations for further invasive plant management training needs. Recommendations are provided in Section 5.6 of the Feasibility Study. Training providers and mentoring from suitable agencies is available. Meeting this objective is Feasible.

The author's view is that the proposed project: Management of Invasive Plants within a Proposed Protection Area, Olum Watershed, Kosrae, is feasible with a very high likelihood of success.

Table 8: Key issues to be resolved before the project can proceed

Issue	Recommendation
Ensure that Kosraean authorities continue to support the project	On-going consultation with Kosraean authorities
Obtain support within the Malem municipality for a community programme approach to assist in the management of invasive plant species	Continue the liaison with the Malem community, recording the dates of meetings and evidence of community support
Obtain required funding	KCSO will seek funding to achieve the next steps of the project
Obtain field team members	KCSO will coordinate the project, working collaboratively with Kosraean government agencies and the Malem / Itut communities
Field team members not qualified to apply herbicides or familiar with managing areas of high biodiversity value	Project manager, coordinator and field team members complete a herbicide users training course (in budget) and seek additional funding to visit example sites where high-value biodiversity areas are protected from threats (not in budget).
Field team members not familiar with a wide range of invasive plant management techniques	Seek additional funding to visit example sites where a range of invasive plant management techniques can be observed so that team members can be upskilled by an expert advisor

7 REFERENCES

Conservation International Foundation and Kosrae Conservation and Safety Organisation, 12 July 2011. Grant agreement and project proposal.

David H. Lorence & Timothy Flynn, National Tropical Botanical Garden 3530 Papalina Road, Kalaheo, Hawaii 96741 USA. Updated 1 September 2009. Checklist of the plants of Kosrae, F.S.M.

Kosrae Conservation and Safety Organisation, undated. Assessment Report for Olum watershed (January 2009 – August 2009). US Forest Service.

Kosrae Conservation and Safety Organisation. Protecting Kosrae's Upland Forest (PowerPoint). 17 July 2012.

Pacific Adaptation to Climate Change, Kosrae. Invasive Species and Climate Change (PowerPoint). 17 July, 2012.

Paynter, Quentin. September, 2010. Prioritisation of targets for biological control of weeds on Pacific Islands. Landcare Research.

PIER Website: http://www.hear.org/pier/index.html

8 APPENDICES

8.1 Appendix 1: Stakeholder meeting and site visits

8.1.1 Stakeholder Meeting:

Date: 17 July 2012.

Venue: Department of Resources and Economic Affairs

Attendees: Jacob Sanney, Dison Kephas, KCSO.

Leon Sigrah, Invasive Species Coordinator, Kosrae Island Resource Management Authority.

Jason Jack, Invasive Species Coordinator, Department of Resources and Economic Affairs.

Erick Waguk, Forestry Coordinator, Kosrae Island Resource Management Authority.

Hamilson Phillip, Olum landowners' representative.

Reverend Madison Nena, Small grant programme coordinator.

John Marrdin, farmer, Utwe Municipality.

Derick Joseph, Quarantine Inspector.

Carlos Cianchini, Pacific Adaptation to Climate Change Project.

John Mather, Pacific Invasives Initiative.

Discussion: The meeting was opened with a prayer from Rev. Madison Nena. Confirmed the agenda. Went over the project development to date including a PowerPoint presentation; funding from CEPF; survey of native and invasive plants on Kosrae; the promotion of the Olum watershed for formal protection; protection area and invasive plant awareness programmes; identification of areas infested with invasive species; the ten target invasive plant species and others identified by KCSO and government agencies; control work to date; background to the DREA invasive species unit and accomplishments to date; discussion re what is it possible to achieve; native range of some of the target species and other invasive plants on Kosrae; positive effects of invasive species; use of herbicides and public view of their use; draft Kosrae Rapid Response Plan. Confirmed programme for John Mather's visit.

8.1.2 Site Visit 1:

Date: 18 July 2012.

Team:

John Mather, PII.

Jacob Sanney, Dison Kephas, KCSO.

Jason Jack, Invasive Species Coordinator, Department of Resources and Economic Affairs.

Hamilson Phillip, landowner.

Activities undertaken: Walked the boundaries and middle of the proposed protection area, noting any occurrence of the target invasive plant species. Gained an overview of the state of the proposed protection area; occurrence of native and exotic plants including health of native plants and maturity. Noted areas of agro-forestry near boundaries. Observed for any evidence of erosion or soil degradation. Observed the dam and water supply system for the Malem community.

Discussion: Discussed with landowner the history of the site especially regarding vegetation disturbance, invasive plant control completed to date and condition of the native forest; view on the use of herbicides versus organic control methods; future plans for agro-forestry; eco-tourism business; school group visits; family support for the proposed protection area; World War II history of the site and area, cultural importance of the site.

Discussed with Jason Jack, Jacob Sanney and Dison Kephas the occurrence of target invasive plant species within the proposed protection area and elsewhere in the watershed; control methods; school group visits; replanting programme of selected native or endemic plant species; previous plant surveys completed on the site for the New York Botanical Garden; medicinal and cultural value of the plant species within the proposed protection area.

8.1.3 Site Visit 2:

Date: 24 July 2012

Team:

John Mather, PII.

Jacob Sanney, Dison Kephas, KCSO.

Activities undertaken: Surveyed the landowner's housing area and agro-forestry area near the proposed protection area for target or other invasive plant species. Walked through the proposed protection area to check for target and other invasive plant species. Double-checked identification of invasive and native species in the proposed protection area. Viewed the tunnels and other evidence of Japanese occupation within the proposed protection area and in an adjacent area. Surveyed the road, stream and part of the watershed area to Malem village for target or other invasive plant species.

Discussion: Met the landowner, Hamilson Phillip, at his house and discussed control methods for the target invasive plants growing near the house. Discussed medicinal and other values of native plants in the proposed protection area. Also discusses the likelihood of further areas being formally protected to preserve biodiversity and other values.

8.2 Appendix 2: Photos

Target plants as specified by KCSO:

Bronze-leaved clerodendrum (*Clerodendrum quadriloculare*), Tofol. All plants had coppiced and regrown

Leucaena (*Leucaena leucocephala*), roadside with Jacob Sanney, Tofol. Most plants had coppiced and regrown.

Mile-a-minute (*Mikania micrantha*) outcompeted by Merremia (*Merremia peltata*) (note that Merremia is not a KCSO target plant), agro-forestry area, roadside, Tepat.

Siam weed (*Chromolaena odorata*) and Wedelia (*Sphagneticola trilobata*), roadside, causeway to Lelu.

Biological control agent established in Siam weed near the airport: gall fly larvae (*Cecidochares connexa*)

American joint vetch (*Aeschynomene americana*), roadside, Malem-Itut road.

Wedelia (*Sphagneticola trilobata*), mown with a weed-eater, and un-mown in the background, roadside, Malem-Itut road.

Dayflower (*Commelina diffusa), above* (with Jacob Sanney) and below, Tofol.

Dayflower (*Commelina diffusa)*

Paddle grass (*Ischaemum polystachyum),* agro-forestry area near the proposed protection area; below, having been removed by an excavator, Tofol.

Giant bramble (*Rubus moluccanus*), roadside, Utwa area.

Bottle gourd (*Luffa cylindrica*), roadside, Utwa area. Merremia is to the left.

Photos of other plants recorded on Kosrae and referred to in this report:

Water hyacinth (*Eichhornia crassipes*), Tepat.

Honolulu rose (*Clerodendrum chinense*), roadside garden near stream, Malem-Itut road.

Lantana (*Lantana camara*), with the orange and yellow flowers, private garden, Malem-Itut road.

Blue morning glory (*Ipomoea indica*) growing up a power pole stay, roadside, Tepat.

Mission grass (*Pennisetum polystachyon*), roadside, near the causeway to airport, Putuk.

White ginger (*Hedychium coronarium*), Tofol area.

Merremia (*Merremia peltata*), roadside, Tepat area. Below, smothering a banana plantation, Tepat.

Additional photos:

Tunnel in the upper Olum watershed, constructed by the Japanese in World War II.

Water supply reservoir on the Olum stream, near the proposed protection area, Olum watershed

Dison Kephas, KCSO Environmental Educator, teaching school children about native and invasive plants on Kosrae island.

8.3 Appendix 3: Distribution maps; Target invasive plant species

Map showing the approximate distribution of the target invasive plant species on northern Kosrae island. For south-eastern Kosrae, including the area near Malem municipality, refer to the next map.

Location of target invasive species (plus the two new incursion plants; *Lantana camara* and *Clerodendrum quadriloculare*) near the Malem municipality. Colour key in previous map.

8.4 Appendix 4: Biosecurity Checklist

Biosecurity Tasks	Completed?	
Have I given clear verbal biosecurity instructions to **all** trip members?	Yes	No
Have I checked they have understood these instructions?	Yes	No
Have any printed instructions been distributed to team members?	Yes	No
Are all supplies (food and equipment) packed in plastic air-tight and insect-proof containers?	Yes	No
List gear too bulky/awkward to fit into containers here: **(Check these items immediately prior to departure!)** • Gear 1 • Gear 2 • Gear 3 • Etc. *Add more as necessary* (Suggestion: treat equipment with insect spray and leave overnight to kill ants and any other invertebrates that could be hiding in gear)	 Yes Yes Yes	 No No No
Has everything been stored in an equipment room in sealed containers? If not, has it been re-checked immediately prior to departure? (Remember 'extras' like boats, radios, day-bags, last-minute items, etc).	Yes Yes	No No
Check with every member of trip: • All food packed in sealed bags? • All fresh food items checked for presence of ants, snails and other invertebrates? • Boots and other footwear clean and free of soil/seeds? • Packs kept in invasive-free areas or checked and re-packed since? • Packs, pockets, Velcro fasteners, socks, etc., clean of seeds? • Has anyone in party worked in area of known invasives infestation recently?	 Yes Yes Yes Yes Yes Yes	 No No No No No No
IF THE ANSWER TO *ANY* OF THE ABOVE IS "*NO*" – THEN FURTHER ACTION IS REQUIRED!		
What are the added risks on this trip? • Are any items being stored in areas that are not rodent- or insect-proof? • Are we taking fresh food which may contain ants, insects, soil etc.? • Are we leaving/ travelling at night? • Are there planned stops enroute where invasives could enter or exit? • Do we have bulky or non-invasive proof packages • Is the boat/vehicle we are travelling on invasive-free?	 Yes Yes Yes Yes Yes Yes	 No No No No No No
IF THE ANSWER TO *ANY* OF THE ABOVE IS "*YES*" – BE AWARE YOUR TRIP HAS EXTRA RISKS!		
Have I addressed these concerns by identifying 'on-the-spot' solutions? (How do I deal with the added risk to minimise potential risk to the site?).	Yes	No
IF YOUR ANSWER TO THIS IS "*NO*", THEN YOUR TRIP SHOULD NOT PROCEED UNTIL YOU HAVE ADDRESSED THESE ISSUES!		

Biosecurity Tasks	Completed?	
<u>When travelling between sites where known invasives exist, or where invasive species management projects are underway:</u> Are you travelling from the site with the least number of invasive species to the site with the most? If not, are you able to change the order of the visits so that the worst site is visited last?	Yes Yes	No No
1. <u>Before leaving a site</u> • <u>Check that all personnel are free of the invasives at the site</u> • <u>Check that all equipment is free of the invasives at the site</u> • <u>Check that all vehicles/boats are free of the invasives at the site</u>	 Yes Yes Yes	 No No No
2. <u>In transit to the next site</u>: If any sign of an invasive is detected while enroute to the new destination, **STOP**! Do not continue to any other site until the problem has been identified and remedial actions implemented. (NOTE: throwing an invasive out the window of a vehicle or overboard from a boat is not good practice. You do not know where it may end up).		
3. <u>On Arrival at Destination:</u> • Have I inspected all containers for rodent, ant or other invasive entry or damage which could allow such? • Has everything been unpacked or opened up and carefully inspected in an open area? • Have I instructed everyone on rules for disposal of organic and other rubbish? • If planning to go to another site from here, have I considered and established how to apply quarantine procedures before we leave? • If on a daytrip only, have I ensured only day-bags are being taken, and that they have been checked, cleaned and packed only on the day of departure?	Yes Yes Yes Yes Yes	No No No No No
IF YOU HAVEN'T DONE THESE TASKS, WHY NOT?! PLEASE DO IT! It is not possible to totally eliminate the risk of accidental introduction of invasive species - short of prohibiting all trips to the site. However risks can be minimised. Any non-compliance with the checklist above means that you are putting the flora and fauna of the site at an unnecessarily increased level of risk. Please do your bit to help preserve the conservation values of the site.		

8.5 Appendix 5: Species information

TLA	
Local Name in your country	Merike
Common Name	American joint vetch
Family	Fabaceae
Genus	*Aeschynomene*
Species	*americana*
Full scientific name	Aeschynomene americana L.,
Synonyms	Aeschynomene americana L. var. depila Millsp; Aeschynomene glandulosa Poir.;Aeschynomene guayaquilensis G. Don; Aeschynomene javanica Miq. var. luxurians Miq.; Aeschynomene mexicana Colla ;Aeschynomene mimulosa Miq.;Aeschynomene tricholoma Standley & Steyerm.;Hippocrepis mimulosa Noronha
Standard taxonomic abbreviation	
PIER WRA score	12
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	Federated States of Micronesia, Guam, Northern Mariana Islands, Palau, Papua New Guinea, Philippines.
Growth habit	Herb
Height at Maturity (metres)	0.5 – 2.0 m
Time to Maturity (years or months)	About 2.5 months (10 weeks). A. americana is an annual or short-lived, perennial shrub.
Pollination method (wind, bat, etc.)	Largely self-pollinating.
Flowering period (month(s))	In areas with seasons it is usually early-flowering. In regions with a long growing season it flowers later .e.g. in seasonal Louisiana it flowers in January/February; in long-growing season Central America it flowers in April.
Time from flowering to seed-set (months)	(1)An erect-ascending, annual or short-lived perennial, shrub-like legume, 1 to 2 m tall. (2) Aeschynomene americana, or common Aeschynomene, is a true annual that flowers and produces seed in the early fall. Plants usually die after seed has matured.

Seed Viability (years)	Hard-seeded legume, likely to remain viable for well over 1 year.
Number of seeds/square metre	<1,000 per square metre
Dispersal vectors	Animals (seeds survive passage through the gut); animal coats; seed lodging on machinery; people planting as a nitrogen-fixing plant.
Dispersal distance (metres)	
Long Distance Dispersal vectors	Animals (seeds survive passage through the gut); animal coats; seed lodging on machinery; people planting as a nitrogen-fixing plant.
Long Distance Dispersal distance (metres)	Unknown but could be many km.
Vegetative reproduction	No, stands must regenerate from seed.
Natural Inhibitors to growth	Shade experiments indicated a min. of 45% incident light was required for good A. americana establishment. Allowing light to penetrate through the grass canopy to emerging legume seedlings was important and resulted in better legume stands and higher pasture quality.
Management Options	Once A. americana has established and seeded at a site it is likely to re-establish through viable dormant seed. Review whether management is necessary: www.tropicalforages.info: "Although A. americana has become naturalised through large parts of the tropics and sub-tropics, it is not generally considered a serious weed." The emphasis for management is likely to be to prevent new incursions, to eradicate a detected new incursion if possible, or to prevent establishment within high-value biodiversity areas. Wetland margins with high light levels would be at most risk of invasion. It is also recorded to be a weed of drainage ditches. If newly detected infestations are over a small area (e.g. 10 square metres) then hand-weed and ensure that, if possible, all plants are removed before seed-fall. Tropicalforages website records that A. americana is tolerant of the herbicides trifluralin, 2,4-D, 2,4-DB, MCPA, fluazifop butyl and sethoxydim. It is susceptible to acifluorfen, bentazone, fluroxypyr, imazethapyr and dicamba.
rigin	Native to Central America and tropical South America, extending as far south as Argentina and north to Florida, United States, and the West Indies.
Website/Reference	

TLA	**CHO**
Local Name in your country	Kromolina
Common Name	Chromolaena or Siam weed
Family	Asteraceae

Genus	*Chromolaena*
Species	*odorata*
Full scientific name	*Chromolaena odorata* (L.) King & Robinson
Synonyms	*Eupatorium affine* Hook & Arn., *Eupatorium brachiatum* Wikstrom, *Eupatorium clematitis* DC., *Eupatorium conyzoides*M. Vahl, *Eupatorium divergens* Less., *Eupatorium floribundum* Kunth, *Eupatorium graciliflorum* DC., *Eupatorium odoratum* L., *Eupatorium sabeanum* Buckley, *Eupatorium stigmatosum* Meyen & Walp., *Osmia conyzoides* (Vahl) Sch.-Bip., *Osmia divergens* (Less.) Schultz-Bip., *Osmia floribunda* (Kunth) Schultz-Bip., *Osmia graciliflora* (DC.) Sch.-Bip., *Osmia odorata* (L.) Schultz-Bip.
Standard taxonomic abbreviation	
PIER WRA score	28
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, Palau, Papua New Guinea, the Philippines
Growth habit	Herb
Height at Maturity (metres)	1.5 to 2m
Time to Maturity (years or months)	Less than 1 year.
Pollination method (wind, bat, etc.)	Does not require specialist pollinators. Butterflies have been recorded to collect nectar from Chromolaena odorata and so assist seed production
Flowering period (month(s))	December to January in the northern hemisphere; June to July in the southern Hemisphere (Zachariades et al., 2009).
Time from flowering to seed-set (months)	Less than 2 months (Erasmus, 1985 in Zahcariades et al., 2009). Seeds may also be produced without pollination (Zachariades et al., 2009). Within 8 to 10weeks (NRM, 2001).
Seed Viability(years)	Up to 5 years, depending on whether seed are on the surface or buried (M. Setter pers.comm. In Vanderwoude et al., 2005). Up to 4 years (Orapa, 2004). At least 8 years (Weeds in Australia, 2003).
Number of seeds/square metre	2,000 to 260,000 seeds/square metre/annum (Witkowski, 2002).
Dispersal vectors	Tiny hooks on seeds enable them to be transported on the backs of animals or clothing, or on vehicles and machinery (McFadyen, 2002). Water currents, hikers' clothes and boots, movement of machinery and equipment, on animals (GISD, 2006).

Dispersal distance (metres)	Long-distance via wind (will depend on the height of the take-off point, but probably easily 1 km or more).
Long Distance Dispersal vectors	Humans (deliberate and accidental introduction - accidental transport of seed in contaminated soil. Humans - cultivated as ornamental. Movement of military equipment and personnel major vector for long distance spread (McFadyen, 2002).
Long Distance Dispersal distance (metres)	Long-distance via wind (will depend on the height of the take-off point, but probably easily 1 km or more).
Vegetative reproduction	Stem and root fragments
Natural Inhibitors to growth	Shade
Management Options	Preventative measures: A risk assessment for Chromolaena odorata resulted in a high score of 28, indicating a high likelihood of the species becoming a major invasive pest plant (PIER, 2011). The best management strategy is prevention, and vigilance is crucial in detecting the weed to prevent its establishment and spread in the Pacific Islands. Occurrences of C. odorata should be reported to the local quarantine authorities, as early detection can increase the chances of successful eradication (Orapa, 2004). Cultural control: Dissemination of public awareness on the adverse environmental impacts of C. odorata is crucial for community co-operation in controlling the weed and detecting infestations. Mail order seeds are a potential source of infestation, and the public should be discouraged from purchasing propagules from the internet or mail order catalogues without first consulting quarantine authorities (Weeds in Australia, 2003). Manuall control: Orapa (2004) lists a number of physical techniques which may suppress the growth of C. odorata. These include: hand pulling, slashing, and uprooting young plants. Slashing and burning are also feasible options, but while biomass may be reduced, regrowth will occur, usually more copiously, from rootstocks. Mulch application, cover crop cultivation, or shading out with canopy-forming crops can diminish the success of re-establishment of C. odorata (Orapa, 2004). The Queensland Department of Employment, Economic Development, and Innovation (DEEDI) (2011) state that manual removal of the basal root ball is an effective means of physical control, and is recommended for small-scale infestations. However, care should be taken to ensure that the uprooted plants do not have any further contact with soil, as this will result in resprouting (DEEDI, 2011). According to Goodall and Erasmus (1996), hand-pulling is, in general, carried out only when populations of the weed have been greatly reduced after chemical treatment, and manual removal of seedlings becomes a more cost-effective option. Chemical control: Orapa (2004) recommends the application of triclopyr for plants in the early seedling or regrowth stages. A mixture of 2,4-D amine and picloram may be effective in causing mortality of both aboveground and belowground parts of the weed. DEEDI (2011) suggest the following chemical treatments: 1) overall spray, or spraying to the point of runoff of picloram and triclopyr (Grazon extra), at a rate of 350ml to 100L of water combined with a BS wetting agent at 100ml to 100L; 2) high volume spray or diluted with water of fluxroxypyr 333 g/L at a rate of 45 to 900ml per 100L water; 3)high volume treatment or spot spray of a combination of fluxroxypyr 140 g/L, aminopyralid 10g/L, and liquid hydrocarbon 418 g/L at a rate of 500 to 700ml per 100L water; and 4) spot spray of metsulfuron-methyl 600g/kg at a rate of 10g per 100L water plus wetting agent, or 100 g/ha plus wetting agent. Goodall and Erasmus (1996) further review a number of herbicide treatments – including imazapyr, glyphosphate, metsulfuron-

	methyl, sulfosate, and tebuthiuron – for C. odorata in South Africa. The information can be accessed at http://ac.els-cdn.com/0167880995006478/1-s2.0-0167880995006478-main.pdf?_tid=3aaf82cb2a159d7ec6d71ac68a34b998&acdnat=1336429293_36ed59e64015164ddd3aef35948dfbd9 Biological control: Biological control is a significant management strategy for Chromolaena odorata across the globe. Results of biological control of the weed have been variable. Successes and failures of biological control attempts of several agents across a range of countries are reviewed and discussed in Muniappan and Bamba (2000). Zachariades et al. (2009) also summarises and reviews a number of established biocontrol agents employed for the management of the weed, and these include: Pareuchaetes pseudoinsulata Rego Barros (Lepidoptera: Arctiidae), Paracheutes insulata Walker (Lepidoptera: Arctiidae), Cecidochares connexa Macquart (Diptera: Tephritidae), Actinote spp. (Lepidoptera: Nymphalidae), Calycomyza cupatorivora Spencer (Diptera: Agromyzidae), and Acalitus adoratus Keifer (Acarina: Eriophyidae). Several other arthropod agents, which have been used for controlling the weed but have failed to establish have also been outlined by Zachariades et al. (2009). These include: Apion brunneonigrum Beguin-Billecoq (Curculionidae), Mescinia nr. parvula (Zeller) (Pyralidae), and Pareuchaetes aurata aurata (Butler) (Arctiidae). Integrated control: An integrated control trial performed by Goodall and Erasmus (1996) revealed that an area treated with fire and oversowing substantially reduced chances of reinfestation due to achene and seedling death, and thus promoted the growth of desirable native species. Costs of oversowing and planting, however, may be high, and natural succession is a more cost-effective option. However, follow-up action is required to ensure long-term success. Infested areas should thus be treated by fire, and policies for limited grazing should be implemented in order to reduce disturbance levels and speed up grass growth and natural succession (Goodall and Erasmus, 1996).
Origin	From Florida through the West Indies, and from Texas through central and South America to Argentina (PIER, 2011).
Website/Reference	http://www.hear.org/pier/species/chromolaena_odorata.htm http://www.issg.org/database/species/ecology.asp?si=47&fr=1&sts=

TLA	**HOR**
Local Name in your country	Sra sroninmutuk
Common Name	Bronze-leaf
Family	Lamiaceae
Genus	*Clerodendrum*
Species	*quadriloculare*
Full scientific name	*Clerodendrum quadriloculare* (Blanco) Merr.
Synonyms	*Ligustrum quadriloculare* Blanco
Standard taxonomic abbreviation	
PIER WRA score	11

Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	American Samoa, Northern Mariana Islands, Federated States of Micronesia, French Polynesia, Guam, Hawaii Marshall Islands, Samoa
Growth habit	Shrub or small tree
Height at Maturity (metres)	2 to 5m
Time to Maturity (years or months)	Fast-growing bush (< 2 years?)
Pollination method (wind, bat, etc.)	Requires specialist pollinators (very long corolla tube).
Flowering period (month(s))	
Time from flowering to seed-set (months)	
Seed Viability(years)	
Number of seeds/square metre	
Dispersal vectors	Bird-dispersed (PIER, 2005).
Dispersal distance (metres)	Prolific producer of root suckers and can by propagated from root cuttings (Space and Flynn, 2000)
Long Distance Dispersal vectors	Humans (introduced as garden ornamentals) (Meyer, 2000; Space et al., 2003).
Long Distance Dispersal distance (metres)	1000 m
Vegetative reproduction	Prolific producer of root suckers and can by propagated from root cuttings (Space and Flynn, 2000)
Natural Inhibitors to growth	Is shade tolerant and freely suckers and shoots if cut.

Management Options	Preventative measures: A risk assessment for Clerodendrum quadriloculare produced a score of 11, indicating a high likelihood of the species becoming a major invasive pest plant (PIER, 2005). Cultural control: Space and Flynn (2000) state that all that can be done about the prevalence of invasives such as C. quadriloculare is to discourage any further planting and to control as needed on a local scale. Manual control: Dr. Apatia Macanawai from the Department of Agriculture in Fiji in an article on Islands Business International (2012), advises slashing off the canopy top , making a slit in the cut stem, and immediately applying glyphosphate into the slit. Chemical control: In the same article, Macanawai (2012) recommends the use of glyphosphate to treat the weed. Plastic bottles with holes punched into the lids can be used as hand sprayers. It is further stated that the only tested herbicide discovered to be effective in controlling C. quadriloculare is Invader (600g/L triclopyr present as butoxyethyl ester), which should be applied as a foliar spray (IBI, 2012).
Origin	New Guinea, the Philippines (PIER, 2009).
Website/Reference	

TLA	
Local Name in your country	Mah fusrasr
Common Name	Dayflower
Family	Commelinaceae
Genus	*Commelina*
Species	*diffusa*
Full scientific name	Commelina diffusa Burm.f
Synonyms	*Commelina nudiflora*
Standard taxonomic abbreviation	
PIER WRA score	23
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	See Origin, below
Growth habit	herb
Height at Maturity (metres)	Creeping **herb** producing short erect branches; **leaves** suboblong, up to 8 cm long and 4 cm wide, glabrous; spathe boat-shaped, to nearly 4 cm long; **flowers** bright blue, or rarely white" (Stone, 1970)."Annual **herbs** with fibrous root system; **stems** at first erect, later decumbent, rooting at the nodes, up to 4 dm long, glabrous or nearly so.

Time to Maturity (years or months)	1 year.
Pollination method (wind, bat, etc.)	Insects e.g. bees, flies
Flowering period (month(s))	Over mid-spring to late summer / fall months in temperate climates.
Time from flowering to seed-set (months)	< 1 year.
Seed Viability(years)	Some evidence from Japan that it is less than a year.
Number of seeds/square metre	More than 1,000 per square metre.
Dispersal vectors	Water (flood waters and streams) carrying seeds or stem fragments (where it roots readily at the nodes). Machinery. People.
Dispersal distance (metres)	Could be >1 km with water movement.
Long Distance Dispersal vectors	Water movement and machinery.
Long Distance Dispersal distance (metres)	Could be >1 km with water movement.
Vegetative reproduction	Yes – roots readily at the stem nodes.
Natural Inhibitors to growth	Hot, dry areas.

Management Options	[Well controlled by herbicides?] "Wilson's (1981) review on the control of these weed species was directed towards finding suitable chemicals for their control in the early stages of growth, summarizing results of trials from difference parts of the world. However, he suggested that since dense mats of plant material make chemical weed control of older plants difficult, removal by hand is the only effective control at that stage (Wilson, 1981). Currently, chemical control is still generally considered the only practical means of controlling large infestations of Commelina species (Ferrell et al., 2004; Webster et al., 2004; Webster et al., 2006). However, no single method of control seems to be effective for control of Commelina spp. in any crop. The difficulty lies in its ability for regeneration after attempted management even by cultural, mechanical or chemical control. An Integrated Management Strategy (IWM) is therefore suggested for the best control of this weed species. Webster et al., (2006) suggested a multi-component approach including an effective herbicide for successful management. Herbicides are not usually very effective against most Commelina species. The first verified resistance was registered in 1957, when C. diffusa biotypes were identified in the United States (Hilton, 1957). Commelina elegans has shown resistance to growth – regulator type herbicides (Ivens, 1967). CABI (2002) however, indicated that control using herbicides is variable depending on the herbicide, accuracy of leaf coverage and environmental conditions. Spraying with a selective or non – selective herbicide may work but repeated treatments are required for regrowth. Plants should not be under moisture stress when sprayed. Surfactants will improve penetration into the waxy coated leaves. Wilson (1981) indicated that many standard herbicides have relatively low activity on species of Commelina. These include 2,4-D, propanil, butachlor, trifluralin and pendimethalin. Treatment with 2,4-D or MCPA at the pre-emergent stage has been shown to be ineffective and although a reasonable kill of very young seedlings can be obtained, the plants develop a rapid resistance with age (Ivens, 1967). Particular biotypes are resistant to 2,4-D and they may be cross resistant to other Group O / 4 herbicides (WeedScience.org, 2005). It has been found that one biotype of C. diffusa could withstand five times the dosage of a susceptible species (WeedScience.org, 2005)."
Origin	Tropical Asia extending eastward into Polynesia, including Hawai'i. Whether or not it is an early introduction to the Pacific appears to be an open question. Whistler (1988; p. 41) states that it is an aboriginal introduction to Western Polynesia.
Website/Reference	

TLA	
Local Name in your country	Mah sacnsrihk
Common Name	Paddle grass
Family	Poaceae
Genus	*Ischaemum*
Species	*polystachyum*
Full scientific name	*Ischaemum polystachyum* J. Presl
Synonyms	Andropogon mariannae Steud.. Andropogon paniceus Steud., Ischaemum chordatum (Trin.) Hack. ex Warb., Ischaemum digitatum Brongn., Ischaemum digitatum var. polystachyum (J. Presl) Hack, Ischaemum intermedium Brongn., Spodiopogon chordatum Trin.

Standard taxonomic abbreviation	
PIER WRA score	20
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	Many Pacific Island locations. In New Guinea on roadsides, garden clearings and grasslands from sea level to 6,000 feet (Henty, 1969; p. 117). Suspected of being introduced to Kosrae through introducing cattle from Pohnpei.
Growth habit	Sprawling grass
Height at Maturity (metres)	To 1.5 m high, but will sprawl at least 1.5 m.
Time to Maturity (years or months)	1 year.
Pollination method (wind, bat, etc.)	Self-fertilization.
Flowering period (month(s))	Unknown, but probably over a long period in the tropics.
Time from flowering to seed-set (months)	< 1 year.
Seed Viability (years)	> 1 year.
Number of seeds/square metre	“Prolific”.
Dispersal vectors	Externally on animals or clothing, contaminated machinery, planted by people.
Dispersal distance (metres)	Could be > 1 km.
Long Distance Dispersal vectors	Externally on animals or clothing, contaminated machinery, planted by people.
Long Distance Dispersal distance (metres)	Could be > 1 km
Vegetative reproduction	Vegetative propagation and viable seed
Natural Inhibitors to growth	Does not tolerate heavy shade.

Management Options	Review the requirement for control. Assess the benefits versus the negative aspects of the grass being present. Once established, an on-going control programme is likely to be required to prevent reinvasion. Physical control will involve removing all of the seed-heads and rhizomes. Any emergent shoots will need to be dug up and remaining portion of rhizome removed. Any seedlings will need to be weeded out before themselves setting seed or producing difficult to remove rhizomes. Control with glyphosate herbicide can be very effective. Thick weed mat, well pinned down, may assist in keeping areas free of growth. Rhizomes and seed may remain viable beneath the weed mat for several years at least.
Origin	Native to Philippines to New Guinea. Uncertain as to native range in the Pacific.
Website/Reference	PIER.

TLA	**LEL**
Local Name in your country	Rohbohtin
Common Name	Leucaena
Family	Fabaceae
Genus	*Leucaena*
Species	*leucocephala*
Full scientific name	*Leucaena leucocephala* (Lam.) de Wit
Synonyms	*Acacia leucocephala* (Lamark) Link 1822, *Leucaena glabrata* Rose 1897, *Leucaena glauca* (L.) Benth. 1842, *Mimosa leucocephala* Lamark 1783
Standard taxonomic abbreviation	
PIER WRA score	15
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	American Samoa, Chile (offshore islands), Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, Ecuador, French Polynesia, Hawaii, Guam, Japan (offshore islands), Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Philippines, Pitcairn Islands, Samoa, Solomon Islands, Tonga, United States (Pacific offshore islands), Vanuatu, wallis and Futuna
Growth habit	Tree
Height at Maturity (metres)	Up to 5m (PIER, 2012).

Time to Maturity (years or months)	Flowering occurs 3 to 4 months after planting (Walton, 2003). InBotswana, 2 - 4 months after planting (Kaminski et al. 2000 in Walton, 2003).
Pollination method (wind, bat, etc.)	Insects, including large and small bees. Also, self-pollinating (GISD, 2010). Generalist pollinators, but the species is also self-fertile (CABI, 2012). Flowers self-fertile; most seed produced by self-pollination (World AgroForestry Centre, n.d.)
Flowering period (month(s))	Throughout the year if sufficient moisture available
Time from flowering to seed-set (months)	Fruit ripen at 10 to 15 weeks (CABI, 2012). Onset of fruiting (days from first flower buds to first pods) for 2 subspecies were: 32-48days and 24-62 days respectively (Walton, 2003).
Seed Viability(years)	at least 20 years. At least 10 - 20 years (Olkers, 2011).
Number of seeds/square metre	<1000, but commonly about 400 seeds per cluster of pods.
Dispersal vectors	Gravity, water, livestock movements; seeds may also be moved by ground insects and rodents (CABI, 2012). Rodents, granivorous birds, and cattle manure (PIER, 2012). Gravity -seeds dispersed by pods splitting or dehiscing (Walton, 2003).
Dispersal distance (metres)	About 20m if unaided (Walton, 2003). Wind-assisted movement resulted in seeds dispersed up to 100m away from parent plant (Walton, 2003).
Long Distance Dispersal vectors	Rain and water, expecially floodwaters (CABI, 2012). Humans (planted for fodder) (DPI&F, 2007). Humans - cultivation for nursery trade, agroforestry, landscaping; water; accidental spread as contaminant (Walton, 2003).
Long Distance Dispersal distance (metres)	Seed not wind disbursed. Viable through an animal's gut. Machinery could carry the seed long distances (i.e. several km at least).
Vegetative reproduction	Regenerates from basal shoots (CABI, 2012). Resprouts from cut stumps and propagates from cuttings; regeneration from basal shoots as well (PIER, 2012).
Natural Inhibitors to growth	As a tropical plant, the species's growth is limited by temperatures (CABI, 2012). Frost (Walton, 2003).Not shade tolerant, a light demanding plant
Management Options	Preventative measures: A risk assessment of Leucaena leucocephala produced a high score of 15, indicating the species' potential to become a significant plant pest (PIER, 2005). Cultural control: As a highly palatable species, the control of the weed through livestock grazing is an option and a possibility (CAB International, 2012). In forest nurseries in India, a plastic sheet covering moist soil for one month resulted in increases in soil temperatures by 10 to 12 degrees Celsius, and this in turn led to 100% mortality of plants and seeds of L. leucocephala through solarisation (CAB International, 2012). In Java, where the weed is planted as a plantation shade tree, sterile hybrids were used instead of reproductive individuals, to reduce the risk of spread (Hughes, 1994 in CAB International, 2012) Physical control: Hand-pulling or digging is suitable for young plants, though all root mass must be removed due to the potential of the tree to resprout. For more mature individuals, cutting must be followed-up with herbicide treatment (CAB International, 2012). A blade plough may be able to cut the root low enough, and cultivation of land will subsequently kill most trees and roots Walton, 2003). The cut material can be mulched (with seed pods removed) and applied to treated areas, which will facilitate establishment of other fast-growing desirable species. The mulch will also inhibit establishment of L. leucocephala seedlings (Walton, 2003). MacDonald et al. (2008) state that repetitive cutting will eventually kill larger trees, while frequent

	mowing and grazing will kill smaller plants. Manual control may not be feasible for large individuals or extensive infestations (DPI&F, 2007). Chemical control: Langeland et al. (2011) report 10% to 20% Garlon 4 to be effective as basal bark or cut stem treatments for some cases, but only with partial success in others. Large trees need to be girdled completely for frill or girdle applications. Experimental applications of Milestone are found effective with basal bark, cut stump, and foliar applications (Langeland et al., 2011). The Department of Primary Industries and Fisheries (2007) list a number of registered herbicides for treating L. leucocephala, together with recommended treatment methods and rates. All methods listed involve a combination of triclopyr and picloram (DPI&F, 2007). More information is available at http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Leucaena-PP85.pdf . Replicated herbicide trials found a number of other chemicals effective in treating L. leucocephala: Lontrel (foliar spray at 5ml/L), Roundup (foliar spray at 10mL/L), Garlon (basal bark at 16.7mL/L), Starane 200 (basal bark 35mL/L) and Tordon TCH (stem injection method at 333mL/L) (Walton, 2003). Biological control: The seed beetle Acanthoscelides macrophthalmus (Schaeffer) was released after host-specificity was confirmed. Impacts of the beetle on the species' seed dynamics have not been quantified in regions where infestation is most abundant (Olckers, 2011). The beetle was also accidentally introduced to Australia, where 11 to 54% seed damage was reported (Raghu et al., 2005 in Olckers, 2011), and to west Africa where 67% seed damage occurred (Delobel and Johnson, 1998 in Olckers, 2011). A psyllid defoliator, Heteropsylla cubana has unintentionally spread across the globe, resulting in cyclical defoliation of L. leucocephala where it is present. While H. cubana does not cause tree mortality, it reduces vigour of shoots and diminishes the proportion of successful seedlings establishing (Elder 2002 in Walton, 2003). However, Olckers (2011) states that the psyllid does not pose any substantial threat to weed populations in South Africa or other regions of the world despite the occurrence of cyclical defoliations. This is possibly due to cultivation of resistant forms of L. leucocephala, and control by predators and parasitoids (Olckers, 2011; GISD, 2006). A number of fungal pathogens and other insects have also been observed to impact on the weed. Further information is summarised by Walton (2003) at http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Leucaena-PSA.pdf .
Origin	Mexico and Central America. Tropical America (PIER, 2012).
Website/Reference	http://www.hear.org/pier/species/leucaena_leucocephala.htm

TLA	
Local Name in your country	Mah kuri

Common Name	Bottle gourd
Family	Cucurbitaceae
Genus	*Luffa*
Species	*cylindrica*
Full scientific name	Luffa cylindrica (L.)
Synonyms	Luffa aegyptiaca Mill
Standard taxonomic abbreviation	
PIER WRA score	WRA not available.
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	See **Origin** below
Growth habit	Vine
Height at Maturity (metres)	Can grow to 10 metres high if support shrubs, trees or other structure present. Can also scramble along the ground and be mature at ground level.
Time to Maturity (years or months)	1 year.
Pollination method (wind, bat, etc.)	Not recorded. Probably bees.
Flowering period (month(s))	Not recorded.
Time from flowering to seed-set (months)	Not recorded. Probably about 5 months.
Seed Viability(years)	Unknown.
Number of seeds/square metre	Unknown.
Dispersal vectors	Unknown. Probably birds, perhaps rodents.
Dispersal distance (metres)	Unknown.
Long Distance Dispersal vectors	Unknown.
Long Distance Dispersal distance (metres)	Unknown.
Vegetative reproduction	Unknown. Stems of many Cucurbitaceae produce roots where they contact the ground.

Natural Inhibitors to growth	Unknown.
Management Options	No management methods recorded. Probably cut out of the support canopy i.e. cut all stems at 1 m and again at 2 m above ground level so that it can be clearly seen that all stems in the canopy have been extinguished. Either dig out all of the rooted material from the ground; or apply a suitable herbicide to the remaining stems from ground level to 1 m high. Typically they all lay on the ground and herbicide can be applied. Depending on the site, proximity of desirable vegetation and future use of the site as to which herbicide is used. Glyphosate or triclopyr at overall herbicide application rates may be suitable.
Origin	Luffa cylindrica is widely distributed in the tropics and subtropics, as a cultivated and naturalized plant. Its cultivation is of ancient origin and it is hard to determine whether the native home is Africa or Asia. The plant occurs wild in West Africa, but this is often believed to be a result of escape from cultivation, as the plant is known as 'white people's sponge' in several communities in the region. However, evidence of an Asian origin is rare. How the plant has spread over the entire tropical zone is also not clear. Some argue for ocean currents as a dispersal mechanism, but more often human dispersal is raised as the probable cause of the wide distribution of Luffa cylindrica. Luffa comprises 7 species, 4 of these native to the Old World tropics and 3 somewhat more distantly related species indigenous to South America. Luffa cylindrica hybridises with other species of the genus, but in most cases hybrids show a great reduction in fertility or even sterility. Hybrids of Luffa cylindrica and Luffa acutangula are found in cultivation. These are bitter and inedible, but suitable for the production of sponges. Within Luffa cylindrica cultivated and wild forms are distinguished: – Smooth Loofah Group (synonym: var. aegyptiaca): the large-fruited, less bitter, cultivated forms, with different cultivars for the production of the best sponge or the best vegetable. – var. leiocarpa (Naudin) Heiser & Schilling: the wild forms occurring in Asia.
Website/Reference	http://www.prota4u.info/protav8.asp?h=M4&t=Luffa&p=Luffa+cylindrica

TLA	**MIK**
Local Name in your country	Mah Tepat
Common Name	Mile-a-minute
Family	Asteraceae
Genus	*Mikania*
Species	*micrantha*
Full scientific name	Mikania micrantha (L.) Kunth.
Synonyms	Refer to: www.theplantlist.org/tpl/record/gcc-1953
Standard taxonomic abbreviation	

PIER WRA score	25
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	American Samoa, Northern Mariana Islands, Cook Islands, Kosrae Island, Fiji Islands, Guam, Marshall Islands, New Caledonia, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau Group, Tonga, Vanuatu, Wallis and Fortuna.
Growth habit	vine
Height at Maturity (metres)	Varies according to habitat at site. Commonly smothers shrubs and small trees.
Time to Maturity (years or months)	1 year.
Pollination method (wind, bat, etc.)	Reproduces sexually by seeds, and vegetatively by rooting at nodes.
Flowering period (month(s))	
Time from flowering to seed-set (months)	
Seed Viability(years)	
Number of seeds/square metre	1,000 per square metre
Dispersal vectors	Wind, clothing, hair, machinery (seed or vegetative material), water e.g. streams. Also apparently taken to locations (e.g. India) after the Second World War to camouflage airfields. Also spreads via broken stem fragments.
Dispersal distance (metres)	Long-distance via wind (will depend on the height of the “take-off point”, but probably easily 1 km or more).
Long Distance Dispersal vectors	Wind, animals, water current.
Long Distance Dispersal distance (metres)	Long-distance via wind (will depend on the height of the “take-off point”, but probably easily 1 km or more).
Vegetative reproduction	
Natural Inhibitors to growth	Prefers partial shade rather than very dense shade.

Management Options	Chemical: Control of Mikania micrantha is difficult, because of the high output of viable seeds, and because new plants can grow from even the tiniest stem fragments. Other than complete destruction of all the stems, herbicides provide the only suitable method of control at present (Northern Territory Department of Business, Industry and Resource Development). "Probably susceptible to: 1) many residual herbicides at standard rates; 2) translocated herbicides including glyphosate and 2,4-D before flowering; 3) contact herbicides (including paraquat) while still a seedling; however established plants will probably recover from the base" (Swarbrick, 1997 in PIER, 2003). Biological: Liothrips mikaniae was introduced into Solomon Islands in 1988, but failed to establish (Swarbrick, 1997). "A number of very promising (and probably specific) natural enemies are known in Central and South America… Of these a thrips, L. mikaniae appears to be specific and to have considerable potential as a biological control organism. A bug, Teleonemia sp., several beetles and an eriophyid mite, Acalitus sp. also warrant serious consideration. A number of other natural enemies of little known specificity also attack M. micrantha" (Waterhouse and Norris, 1987). Fungal pathogens have also been investigated in India as a potential biological control method (Swarbrick, 1997 in PIER, 2003). Oceania: At two regional technical meetings on plant protection and biosecurity in March 2002 and March 2004, 11 Pacific Ocean countries rated mile-a-minute (M. micrantha) and giant sensitive plant (Mimosa diplotricha) among their top 10 worst weedsThe meetings further resolved for the Secretariat of the Pacific Community (SPC) to assist Pacific Island Countries and Territories to address major weeds of the region. As a result, SPC submitted a proposal to ACIAR to fund a major biocontrol project against these two weeds. Both M. micrantha and M. diplotricha were rated in the “most important” category and have good prospects for biocontrol. Three countries, Papua New Guinea (PNG), Fiji and Samoa, which rated both weeds highly, were chosen to be initial implementers of the proposed project as they showed initial interest and had suitable facilities to implement the activities. A project development visit to Fiji, PNG and Samoa was carried out by Warea Orapa, Coordinator Weed Management, and Michael Day, an Entomologist based at Alan Fletcher Research Station, Queensland to establish linkages and discuss the proposed project on the two weed pests. Because of conflicting views on Mikania in Samoa, Samoa has officially opted to wait till the research work is completed in Fiji and PNG. In addition, the proposed project may concentrate only on Mikania biocontrol since field populations of the psyllid Heteropsylla spinulosa, released in these countries under the GTZ Biocontrol Programme in Fiji and Samoa in the mid-1990s and independently released in PNG (by Ramu Sugar in 1992), are established. M. micrantha in PNG has long been regarded as a problem weed, especially in large plantation areas as well as smallholder farms on New Britain Island and several other areas. Support for a biocontrol project has been aired since 2002 by the National Agricultural Research Institute (NARI) and the Cocoa and Coconut Institute. For more information contact WareaO@spc.int (Pacific Pest Info, No. 55, January 2005)
Origin	Mikania micrantha was introduced into India after the Second World War to camouflage airfields (New Scientist, 2003).
Website/Reference	

TLA	
Local Name in your country	Kokul
Common Name	Giant bramble
Family	Rosaceae
Genus	*Rubus*
Species	*moluccanus*
Full scientific name	*Rubus moluccanus Linnaeus*
Synonyms	Rubus capricorni, Rubus hillii, Rubus moluccanus var. dendrocharis
Standard taxonomic abbreviation	
PIER WRA score	WRA not available.
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	See **Origin** below
Growth habit	Shrub
Height at Maturity (metres)	2 to 3 meters
Time to Maturity (years or months)	1 year.
Pollination method (wind, bat, etc.)	Flowers are insect-pollinated. Fruits are dispersed by birds (PIER, 2002).
Flowering period (month(s))	Spring / early summer in temperate climates.
Time from flowering to seed-set (months)	4 months
Seed Viability(years)	Unknown, but probably several years.
Number of seeds/square metre	< 1,000
Dispersal vectors	Birds, rodents, pigs. People.
Dispersal distance (metres)	> 1 km via bird-borne seed
Long Distance Dispersal vectors	Birds

Long Distance Dispersal distance (metres)	> 1 km possible.
Vegetative reproduction	Capable of rooting along canes
Natural Inhibitors to growth	Prefers lowland areas such as forest margins or disturbed areas. Less fruiting and eventual decline in heavy shade.
Management Options	No specific management information was found for R. moluccanus, but techniques used for the control of blackberry (Rubus fruticosus agg.), which is a related species, may be applicable. These are outlined below. Mechanical control: Tractor and rotary slasher, hand cutting. Chemical: There are a range of herbicides that can be used for the control of blackberry, including those that are glyphosate-based, such as Roundup®. These are usually applied by spraying, using a knapsack or mistblower for smaller infestations, or handgun and hose for larger ones (Mallinson, 1998). Biological: Maintenance of soil fertility and pasture may reduce infestations. Goats (Capra hircus) are able to control infestations through grazing. Care must be taken with this approach however, as goats are a known invasive species as well.
Origin	Himalayas through Malaysia to Australia, Solomon Islands, New Caledonia and Fiji. Smith (1985; pp. 39-40) says that var. austropacificus van Royen is indigenous to the Caroline Islands, New Britain [Vanuatu], the Solomon Islands, northern Australia, New Caledonia and Fiji. Fosberg, Sachet & Oliver (1979; p. 89) list it as a native on Kosrae.
Website/Reference	PIER. ISSG.

TLA	**TRD**
Local Name in your country	Ros rangrang
Common Name	Trailing Daisy or Wedelia
Family	Asteraceae
Genus	*Sphagnetticola*
Species	*trilobata*
Full scientific name	*Sphagneticola trilobata* (L.C. Rich.) Pruski
Synonyms	*Acmella brasiliensis* Spreng., *Acmella spilanthoides* Cass., *Buphthalmum repens* Lam., *Buphthalmum strigosum* Spreng., *Complaya trilobata* (L.) Strother, *Polymnia carnosa* Poir., *Polymnia carnosa* Poir. var. *aspera* (Rich.) Poir., *Polymnia carnosa* Poir. var. *glabella* (Rich.) Poir., *Polymnia carnosa* Poir. var. *triloba* (Rich.) Poir., *Seruneum paludosum* (DC.) Kuntze, *Seruneum trilobatum* (L.) Kuntze, *Silphium trilobatum* L., *Sphagneticola ulei* O.Hoffm., *Stemmodontia trilobata* (L.) Small, *Thelechitonia trilobata* (L.) H.Rob. & Cuatrec., *Verbesina carnosa* M.Gómez, *Verbesina carnosa* M.Gómez var. *aspera* (Rich.) M.Gómez, *Verbesina carnosa* M.Gómez var. *triloba* (Rich.) M.Gómez, *Wedelia brasiliensis* S.F.Blake, *Wedelia carnea* Rich., *Wedelia carnosa* Rich. ex Spreng., *Wedelia carnosa* Rich. var. *aspera* Rich., *Wedelia carnosa* Rich. var. *glabella* Rich., *Wedelia carnosa* Rich. var. *triloba* Rich., *Wedelia crenata* Rich., *Wedelia paludicola* Poepp. & Endl., *Wedelia paludosa* DC., *Wedelia triloba* (Rich.) Bello, *Wedelia trilobata* (L.) Hitchc.

Standard taxonomic abbreviation	
PIER WRA score	13
Invasiveness Category in your Country	
Decision Tree Result for your plant	
Distribution in Pacific	American Samoa, Cook Islands, Federated States of Micronesia, French Polynesia, Kiribati, Marshall Islands, Guam, Northern Mariana Islands, Nauru, New Caledonia, Niue, Palau, Samoa, Tonga, United States (Midway Atoll)
Growth habit	Herb
Height at Maturity (metres)	10in (Floridata, n.d.). 0.5 to 1 feet (Gilman, 2011). 45 - 60cm high (CAB International, 2012).
Time to Maturity (years or months)	No direct evidence though is a very fast-growing herb
Pollination method (wind, bat, etc.)	Insects e.g. Bees.
Flowering period (month(s))	All year round (Gilman, 2011; CAB International, 2012).
Time from flowering to seed-set (months)	
Seed Viability(years)	No information regarding seed survival.
Number of seeds/square metre	Few fertile seed produced. Spread is mainly vegetative (GISD, 2010).
Dispersal vectors	Wind, people, machinery.
Dispersal distance (metres)	
Long Distance Dispersal vectors	Humans (cultivation for ornamental purposes, or by accidental dumping of waste) (PIER, 2010). Grown as ornamental ground cover in Guam (Muniappan et al., 2002). Ground cover in many areas.
Long Distance Dispersal distance (metres)	
Vegetative reproduction	Stems form new plants where they come into contact with the ground. Pieces sprout roots (PIER, 2010). Stems take root when coming in contact with damp soil. Also, layering (Gilman, 2011).
Natural Inhibitors to growth	Frost (CAB International, 2012)

Management Options	Preventative measures: A risk assessment of *Sphagneticola trilobata* resulted in a high score of 13, indicating the species' potential to become a significant plant pest (PIER, 2005). It is recommended that planting of the species be restricted and existing plants within the landscape be eliminated, with extra caution taken when dumping vegetative material in order to prevent regeneration or accidental introduction to new areas (MacDonald et al., 2008). Early detection and prompt follow-up eradication is required to prevent establishment of the weed. Public awareness is crucial to reduce dumping of garden waste into native vegetation, which can facilitate introduction of weeds to new areas (Batianoff and Franks, 1998). Cultural control: According to CAB International (2012), importation and spread of the weed can be substantially reduced through disseminating public awareness on the identity, impacts to native ecosystems and control methods. *S. trilobata* can also be controlled through the management of nitrogen fertiliser usage and irrigation (CAB International, 2012). MacDonald et al. (2008) suggest planting native or non-invasive alternative species. Space and Flynn (2000) strongly advise an eradication campaign for the species. Manual control: Mowing and slashing should be undertaken with care in areas invaded by *S. trilobata* (DPI&F, 2007). Runners should be hand-pulled and dug up. It is critical that plant waste be disposed of carefully, as regeneration can take place from the smallest cuttings. Waste should either be burnt or put in a black plastic bag and be left to dry. Cleared areas should then be revegetated with mulching, to prevent further weed invasion (DPI&F, 2007). MacDOnald et al (2008) discourage mowing and slashing in infested areas, and instead recommend uprooting of the weed followed by herbicide application. Seedlings and small plants can be hand-pulled, though entire roots and rhizomes should be removed (MacDOnald et al., 2008). CAB International (2012) states that an effectual method of control would be to remove the top few centimetres of soil using an appropriate tool, with the intention of eliminating the soil seed bank of S. trilobata. While hand-pulling is effective, it is not a feasible control method for large-scale infestations. Repeated hand-pulling supplemented with herbicide administrations is usually required. Burning is also an option (CAB International, 2012). Chemical control: In Queensland, a registered herbicide for treating *S. trilobata* invaded areas is metsulfuron-methyl (600g/L), at a rate of 10g per 100L water plus wetting agent. It should be sprayed thoroughly to wet foliage but without resulting in runoff (DPI&F, 2007). Ensbey et al. (2011) recommends glyphosphate (360g/L) at a rate of 200mL per 100L water to be used as a foliar spot spray, as well as a combination of 200mL glyphosphate and 1.5g metsulfuron-methyl (600g/kg) per 10L water for spot spray application. Dense infestations of the weed may require 5% of glyphosphate along with follow-up treatments (MacDonald et al. 2008). Motooka et al. (2003) state that *S. trilobata* is sensitive to dicamba and 2,4-D (minimum of 2 Ib per acre) as well as to triclopyr in crop oil using a drizzle method at 2Ib per acre or more. Spencer (2010), however, found that glyphosphate was ineffectual in controlling *S. trilobat*a, and in addition, led to severe damage of native vegetation due to its properties as a broad spectrum herbicide. In place of glyphosphate, Spencer (2010) recommends metsulfuron-methyl (Brushkiller, Brushoff etc.), which was found to kill the weed efficiently, and with few impacts to native vegetation. In trials conducted to evaluate the effects of spraying on native species, 85% of 80 species of seedlings exposed to metsulfuron-methyl were largely unaffected, or recovered quickly. Certain chemical growth regulators have shown potential in the ability control the height of *S. trilobata* (CAB International, 2012).
Origin	Mexico, Central America, the Caribbean Islands (PIER)
Website/Reference	PIER; GISD.

8.6 Appendix 6: World Bank Guidelines on the use of pesticides

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Pest Management

Operational Policy 4.09: Pest Management: Rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use Integrated Pest Management (IPM) techniques and encourage their use in the whole of the sectors concerned.

If pesticides have to be used in crop protection or in the fight against vector-borne disease, the Bank-funded project should include a Pest Management Plan (PMP), prepared by the borrower, either as a stand-alone document or as part of an Environmental Assessment.

Operational Policy 4.09: Pest Management, 1998

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OP 4.09 - Pest Management

These policies were prepared for use by World Bank staff and are not necessarily a complete treatment of the subject.

OP 4.09

December, 1998

This Operational Policy statement was revised in August 2004 to ensure consistency with the requirements of OP/BP 8.60, issued in August 2004.

Note: This OP 4.09 replaces the version dated July 1996. Changes in wording have been made in paras. 1 and 3 and footnotes 2, 3, and 4. Further guidance for implementing the Bank's pest management policy is in the Environmental Assessment Sourcebook (World Bank: Washington, D.C., 1991). Questions regarding agricultural pest management may be addressed to the Director, Rural Development. Questions regarding pesticide use in public health projects may be directed to the Director, Health Services.

1. In assisting borrowers to manage pests that affect either agriculture or public health, the Bank1supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides. In Bank-financed projects, the borrower addresses pest management issues in the context of the project's environmental assessment.2

2. In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity.

Agricultural Pest Management

3. The Bank uses various means to assess pest management in the country and support integrated pest management (IPM)4and the safe use of agricultural pesticides: economic and sector work,

sectoral or project-specific environmental assessments, participatory IPM assessments, and investment projects and components aimed specifically at supporting the adoption and use of IPM.

4. In Bank-financed agriculture operations, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The Bank may finance the purchase of pesticides when their use is justified under an IPM approach.

Pest Management in Public Health

5. In Bank-financed public health projects, the Bank supports controlling pests primarily through environmental methods. Where environmental methods alone are not effective, the Bank may finance the use of pesticides for control of disease vectors.

Criteria for Pesticide Selection and Use

6. The procurement of any pesticide in a Bank-financed project is contingent on an assessment of the nature and degree of associated risks, taking into account the proposed use and the intended users.5 With respect to the classification of pesticides and their specific formulations, the Bank refers to the World Health Organization's Recommended Classification of Pesticides by Hazard and Guidelines to Classification (Geneva: WHO 1994-95).6 The following criteria apply to the selection and use of pesticides in Bank-financed projects:

(a)They must have negligible adverse human health effects.

(b)They must be shown to be effective against the target species.

(c)They must have minimal effect on nontarget species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies. Pesticides used in public health programs must be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them.

(d)Their use must take into account the need to prevent the development of resistance in pests.

7. The Bank requires that any pesticides it finances be manufactured, packaged, labeled, handled, stored, disposed of, and applied according to standards acceptable to the Bank.7 The Bank does not finance formulated products that fall in WHO classes IA and IB, or formulations of products in Class II, if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

1. "Bank" includes IBRD and IDA, and "loans" includes IDA credits and IDA grants.

2. See OP/BP 4.01, Environmental Assessment.

3. OP 4.09 applies to all Bank lending, whether or not the loan finances pesticides. Even if Bank lending for pesticides is not involved, an agricultural development project may lead to substantially increased pesticide use and subsequent environmental problems.

4. IPM refers to a mix of farmer-driven, ecologically based pest control practices that seeks to reduce reliance on synthetic chemical pesticides. It involves (a) managing pests (keeping them below economically damaging levels) rather than seeking to eradicate them; (b) relying, to the extent possible, on nonchemical measures to keep pest populations low; and (c) selecting and applying pesticides, when they have to be used, in a way that minimizes adverse effects on beneficial organisms, humans, and the environment.

5. This assessment is made in the context of the project's environmental assessment and is recorded in the project documents. The project documents also include (in the text or in an annex) a list of pesticide products authorized for procurement under the project, or an indication of when and how this list will be developed and agreed on. This authorized list is included by reference in legal documents relating to the project, with provisions for adding or deleting materials.

6. Copies of the classification, which is updated annually, are available in the Sectoral Library. A draft Standard Bidding Document for Procurement of Pesticides is available from OPCPR.

7. The FAO's Guidelines for Packaging and Storage of Pesticides (Rome, 1985), Guidelines on Good Labeling Practice for Pesticides (Rome, 1985), and Guidelines for the Disposal of Waste Pesticide and Pesticide Containers on the Farm (Rome, 1985) are used as minimum standards.

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