

**Eradication Project Design
for *Imperata cylindrica* (cogon grass)
Republic of Palau
September 2016**

BACKGROUND

This is a “species-led” project, for the purpose of complete eradication of the invasive plant, *Imperata cylindrica*, from the Republic of Palau. This plant is known locally simply as “imperata.” Its name in Palauan is “*kasoring*” (“gasoline,” in reference to its high flammability) and it is also commonly known as “cogon grass.”

Imperata was first reported in Palau in the 1990’s; an aerial survey was done with the assistance of Dr. Margie Falanruw of the US Forest Service, and maps were made with the assistance of the Palau Automated Land and Resource Information System (PALARIS) showing one main infestation and several small satellite infestations at the eastern end of the international airport runway in Airai State on the island of Babeldaob. A few years later, a small infestation was found on a roadside in Melekeok State, also on the island of Babeldaob, a few miles north of the airport infestation. In 2000, a control project was initiated, following a visit by Duane Nelson and David Bakke of the USFS, who provided training in spray methodology. Support was also provided by the Secretariat of the Pacific Community, with additional advice from our colleagues in Yap, who had already initiated an eradication project for cogon grass in Yap. The control effort in Palau was not well organized initially, no eradication plan was ever developed, and limited resources were allocated to the effort until 2006, when a truck was purchased for this and other invasive plant efforts. Irregular spraying of glyphosate has continued since 2006; informal observations indicate that the density of the infestation has apparently decreased, and the infestation has not spread, but it is now clear that the current level of effort is not likely to result in eradication. A new approach is clearly needed, with a clear plan of action leading to eradication of this invasive grass.

The outline of this plan was developed in a two-day stakeholder workshop held on August 31 and September 1, 2015, with the support of David Moverley, Invasive Species Adviser with SPREP. He is familiar with the situation in Palau, having been here and worked with Forestry staff twice in the past several years. He has also worked with Yap State personnel on their imperata eradication project. The planning workshop received funding support of the USDA Forest Service. Following the workshop, the plan was further developed and completed by Palau’s National Invasive Species Coordinator, Joel Miles, with input and advice from local stakeholders, David Moverley, and David Bakke.

OBJECTIVES

This project has one main objective: the complete eradication of imperata from the Republic of Palau. This will be accomplished by a series of herbicide treatments over a period of three to five years. Initial knockdown of imperata will be accomplished in the

first three to four months of the project; this will be followed by spot treatments of surviving plants every three to six months, depending on how rapidly the survivors regrow. We anticipate that it will take several follow-up treatments to attain complete eradication of this very persistent plant.

PLANT CHARACTERISTICS

Imperata is a very fast-growing grass, growing in dense stands when not controlled. It is well adapted to fire.

Imperata is also allelopathic: the plants produce chemicals which inhibit the growth of other plants. This results, over time, in mono-specific (only imperata) stands, which in some countries cover very large areas. This property also makes it a particularly troublesome weed in farms. The underground stems can actually grow through root crops such as cassava and sweet potatoes.

Imperata spreads in two ways: it spreads vegetatively by underground stems (rhizomes), as well as by wind-dispersed seeds. Both methods of reproduction and spread can be assisted by human activities: farm cultivation; road grading, and other equipment movement can all move both seeds and vegetative propagules. The seeds remain viable in soil for only a short time - no more than a year – with most seeds germinating soon after coming in contact with soil.

Imperata is well adapted to fire: the plants regrow quickly after fire from the underground parts. They also tend to produce seed soon after fire, enabling them to colonize large cleared areas quickly.

In Palau, it appears possible that the plants are not producing viable seed, but this has not been tested or substantiated, and is based on the fact that the infestations have grown only slowly, if at all, and no satellite infestations have appeared, as would be expected from wind-blown seed.

Control of imperata is extremely difficult; there are no truly effective non-chemical methods, although its growth can be inhibited by dense planting of tree species which are tolerant of imperata's allelopathic chemicals. Herbicides which have been shown to be effective against imperata include glyphosate (Roundup), metsulfuron-methyl (Escort), and imazapyr (e.g., Arsenal, Chopper, others). Imazapyr should not be considered for use near any desirable trees or woody brush as it may move through the soil and result in damage. Imazapyr should not be used on steep slopes above sensitive plant species, which will limit its usefulness in most of the project site, but it will be used within the airport perimeter fence. We plan to use a mixture of glyphosate and metsulfuron-methyl for this eradication project.

PROJECT SITE CHARACTERISTICS

There are three sites infested with imperata (see maps in Appendix), all on the island of Babeldaob: the first site is within and around the east end of the runway of the Palau International Airport; this will be separated into three management units: the area within the access road; the area between the access road and the perimeter fence; and the area outside the fence. The second site is in hilly savannah land just southeast of the airport runway, and will be combined with Management Unit 3 for management purposes. The third site is beside the road to Melekeok at the former UMDA development site. We have numbered these sites as Management Units 1, 2, 3, and 4 (MU1, MU2, MU3, and MU4). These Management Units will need to be subdivided into areas which can be treated in one working day. This will be one of the initial tasks in the eradication project, to be accomplished through site visits and GIS mapping.

The airport runway management unit within the access road is relatively flat, with an encircling access road. It is therefore easily accessible physically, but all operations here must be scheduled not to interfere with airport operations, and must comply with security regulations. The site tends to be quite windy: herbicide application is best done early in the morning when it is less likely to be too windy.

The second management unit, between the runway access road the airport perimeter fence, is sloping. It is also readily accessible physically, but has the same restrictions as the first management unit. The same herbicide application equipment can be used for both the first and second management units. As with Management Unit 1, this site tends to be quite windy: herbicide application is best done early in the morning when it is less likely to be too windy.

The third management unit, in hilly savannah, has an access road accessible only by 4-wheel drive vehicles. It is mostly moderately to steeply sloping. It is surrounded by native forest, and there is one small farm within the site. Eradication operations must take these into account. This site is also usually windy. This unit will require both the motorized sprayer and backpack sprayers, depending on the characteristics of the management subunit.

The fourth management unit is adjacent to savannah and forest, and is quite small compared to the other management units. It is also adjacent to an all-weather road, making access relatively easy. Management of this unit will be the same as for MU3.

There are some project site characteristics that make implementation more difficult:

- Runway perimeter within the fence needs to be mown for flights (every month). This management unit will have to be reseeded with a low-growing (and non-invasive) grass/legume mix following the first herbicide treatment. This can be done by hydroseeding, with a complete fertilizer in solution.

- Access to Sites 1 and 2 needs to be organized one week in advance to prevent interference with flight schedules.
 - No equipment can be left on-site in Sites 1 and 2 during take-off or landing of commercial aircraft.
 - The airport perimeter fence limits movement from runway to remaining infestation outside of runway fence.
 - Steep slopes are also infested, making access challenging in some parts of Sites 2 and 3.
 - Part of Site 2 is a working farm.
 - Access road to the site outside of the airport fence requires a 4WD vehicle, particularly when wet.
- ⇒ Must plan ahead, have the correct vehicle and equipment: different parts of the infestation will require a different eradication method due to these limitations.

k) Size of infestations

Site 1: 70,750 square meters

Site 2: 5,171 square meters

Site 3: 1,789 square meters

No satellite infestations known. During the mapping effort for this planning exercise we inspected nearby and downwind farms, savannas, and roadsides and found no satellite infestations. If possible, it would be good to arrange for aerial surveillance as well; *imperata* has a distinctive color which is readily visible from low altitude flight.

Risk of Accidental Dispersal

- Airport to notify BoA of any earthmoving to be implemented e.g. extension of the runway.
- The discing machinery must be thoroughly cleaned – power wash or steam clean – before departing from airport. The eradication plan calls for discing the area within the runway access perimeter road to encourage sprouting of all rhizomes prior to herbicide treatment.
- High risk of Melekok infestation being spread along roadside from grading the road; this was a serious problem in Yap, and it appears that this has happened to some extent here.

TIMING

Imperata appears to be spreading very slowly, only by vegetative spread, at the margins of each site. The Melekeok site may have been moved as much as 100 meters along the roadside by road grading equipment.

It is clear that it is possible to control *imperata* faster than it is spreading.

The dry season is not the ideal time for spraying as plants are under stress. This is normally from mid-January through mid-March, but it varies from year to year.

July/August is not good for operations as it is usually rainy. This also varies from year to year.

2) IMPLEMENTATION

CONTROL METHODS

The primary method of control will be herbicide spraying, with the equipment used depending on the situation. Initial treatment will be broadcast spray of the herbicide mix specified below. For the larger and more accessible areas a motorized power sprayer with an adjustable nozzle will be used; plants will be sprayed until wet. Areas not accessible by the power sprayer will be treated with backpack sprayers using a drizzle nozzle and a higher concentration of herbicide, which was shown to be quite effective in 2002-3. In this case, the key is to have several spots of herbicide (with colored dye for ease of seeing) on each leaf. It is anticipated that only one broadcast spray will be needed, to be followed by spot spraying of plants emerging following the initial treatment. The following methods of control have been selected to be effective, efficient, and utilize the lowest toxicity:

MU1: Disc or cultivate the area one to two months prior to blanket spraying for initial knockdown with motorized spray unit with hose, targeting all species of grasses and plants, monitor for regrowth each month and spot spray imperata. Levelling may be required following discing depending on site condition.

MU2: Spray with complete coverage, using power sprayer, monitor for regrowth and spot spray imperata with backpack sprayer. (We may want to hydroseed this unit as well, as with MU1.)

MU3: Targeted spray application of imperata using power sprayer and/or backpack sprayer with drizzle nozzle, as appropriate to the terrain, monitor for regrowth and spot spray imperata using backpack sprayer.

MU4: (Melekeok), Targeted spray application of imperata using power sprayer and/or backpack sprayer with drizzle nozzle, as appropriate to the terrain, monitor for regrowth and spot spray imperata using backpack sprayer

Initial spray application at most sub-units will be delivered through a motorised spray unit plus backpack sprayers in difficult-to-reach areas, and for follow up spot spraying.

Spray mix:

1) Motorized sprayer (400 liters)

Glyphosate:1%

Metsulfuron-methyl: 20 grams per 400 liter tank

Surfactant: 100 ml per 400 liters

Dye:400 mls

Approximately 500 liters per hectare

2) Backpack sprayer (10 liters)

Glyphosate (Roundup): 4%

Metsulfuron (Escort): 2.5.grams/ 10 liters

Surfactant: 5 milliliters / 10 liters

Dye: 40 milliliters / 10 liters

RESTORATION METHODS

MU1: Hydroseed with lower growing grass species following the first spot spray operation. This will help identification of imperata and to lower the mowing requirement so that the imperata can grow taller making it more visible.

Ground preparation will be conducted in consultation with the airport.

MU2: This area should also be hydroseeded with low-growing grass species following the first spot spray.

MU3: We anticipate that the native savanna species will quickly recover following removal of the imperata. We observed this following spray operations in this area in 2002. The area should be monitored during this period to detect any invasive species which are present nearby.

MU4: (Melekeok) The same as MU3.

b) Who will do the work?

Discing and ground preparation will be done with existing BoA staff and equipment in consultation with airport.

Spray application- Bureau of Agriculture staff.

A minimum of three people are needed for this project; four would be more efficient for backpack operations.

There must be at least one person to run the spray unit and manage the hoses, vehicle, and machinery while using the motorized spray applicator. It would be better to have one person to drive the vehicle while another manages the spray applicator and hoses, while two others do the spray application.

c) When will it be done?

Operations will begin as soon as funding is available. Procurement of equipment and ground logistics mean that the start of operations on the ground will be 6 to 9 months after funds become available.

After 12 months it is expected that the initial knockdown will be complete and at least 2 follow up operations will also have been completed.

d) Equipment Needed

4WD flatbed truck

Transportable (trailer and/or truck-bed mounted) 400 liter motorized spray unit (plus spares) with 2 x 100 meter hoses

4 x backpack sprayers, spares and accessories including nozzles (even flat fan, drizzle, and solid cone)

Personal protective equipment (PPE) for 4 people.

2 way radios for communication at airport

Hydroseeding contractors provide all equipment required.

The Pacific Region Weed-Led Database Management System will be used for recording operations and success measures. This is managed by SPREP. A copy of the database will be given to Palau for this and other invasive plant management projects. We will work closely with both SPREP and PALARIS for storage and analysis of data.

Supplies Needed

Description	Qty		price
Emergency data information <ul style="list-style-type: none"> • Manifest Laminated • Emergency contacts • EM Flowchart 	1		
Spill kit (see tech-ops) 5L	1		
Spill kit (see tech-ops) Larger one <ul style="list-style-type: none"> • Knapsacks(Solo) piston type • Drizzle nozzles • DG9504E Even spray Flat Fan Nozzles • TG2.0 Solid cone nozzles • 5053-50 Strainers S/S • Capnuts 	1		
	4		
	6		
	6		
	6		
	6		
	6		
Agrichemicals			
<ul style="list-style-type: none"> • Glyphosate (Roundup) 	165 L	9 x 20L	
<ul style="list-style-type: none"> • Metsulfuron-methyl (Escort) 	900 g	1 x 1 kg	
Adjuvants			
<ul style="list-style-type: none"> • Agpro Organosilicone surfactant 	1 x 5L		
<ul style="list-style-type: none"> • Agpro Blue dye 	1 x 20L		
Mixing Equipment			
1 liter jugs	4		
500 ml jug	4		
500 ml graduated cylinder	2		
100 ml graduated cylinder	4		
20l Heavy duty plastic containers (marked spray water only)	6		
Funnel 8inch c/w handle	2		
Personal protective equipment			
<ul style="list-style-type: none"> • Goggles 	5		
<ul style="list-style-type: none"> • Nitrile Disposable gloves Large 	5		
<ul style="list-style-type: none"> • Nitrile Disposable Gloves Extra Large 	2		
<ul style="list-style-type: none"> • Hand cream cleaner 	2		
Other Equipment			
Plastic box smaller c/w lid	1		
Large Heavy Duty Plastic Mixing Box c/w lid	1		
Sign Herbicide spraying in progress A Frame type	2		
2-way radios	2		

Office Equipment

Description	Qty		
Laptop	1		
Software	1		
Back up drive	1		
Garmin 60CSX (or equivalent)	1		
Battery charger & batteries	1		
Permanent marker	10		
Flagging tape	5		
Clip board folding type	2		

MAPPING

e) How do you visualise the extent of a “site”, what defines “a site”

- Management Unit 1) inside the airport access road. This area is mown regularly and the grass must be kept short. It is difficult to see individual imperata plants in this unit, unless they are flowering/producing seed.
- Management Unit 2) Between the access road and the fence. Is not cut as regularly as unit 1 and there are obvious patches of imperata.
- Management unit 3) Outside the airport fence including the farm site
- Management unit 4) Melekeok

*All management units will be further split into subunits to suit a four hour session and include a unique ID such as IMP01.

f) How are you going to reference or fix its position in space (on and off site)?

Flagging tape on airport fence which will correspond with existing markers to the satisfaction of the airport.

Flagging tape in the other management units and subunits.

Management units and subunits will be added to the geo-referenced map by PALARIS.

Digital photographs taken at the same site repeatedly over time.

g) How are you going to measure its size?

From the GIS map.

HUMAN RESOURCES

Discing and ground preparation: input required from BoA

Initial control (100 people days)

Follow up operations (50 people days each) If all goes well, it should be possible to complete a treatment cycle every three months. However, anticipating inevitable delays

due to weather and other factors, it is probably more realistic to expect to complete a treatment cycle in four months.

Require four people to complete all areas every three to four months.

Estimated Days to complete treatment of each management unit:

MU1: 5 days

MU2: 3 days

MU3: 12 days, including farm area

MU4: (Melekeok) 1 day

Maintenance, cleaning, administration, data capture: 2 days per treatment cycle

Discing will be done with existing staff and equipment.

Hydroseeding completed by contractors inclusive of labor.

Bureau of Agriculture.

A minimum of three people are needed to implement this project, but four would be more efficient using backpacks. With three people, one person will run the power spray unit and manage the hoses, vehicle, etc., while two people run the spray hoses. With four people, one can drive the vehicle while another manages the hoses from the vehicle. This will improve efficiency and safety. For spraying with backpacks, four people will be able to cover my ground than three.

After the first year, for follow-up work, labor requirements should be reduced to two people.

i) What is the estimated time to treat each site?

MU1: (between runway and access road) 5 days

MU2: (between access road and fence) 3 days

MU3: (outside fence – including farm area) 12 days

MU4: (Melekeok) 1 day

Maintenance, cleaning, administration, data capture, reporting: 2 days

j) What are the key skills personnel need?

To implement control

- Plant identification
- Herbicide mixing, application, and safety
- Equipment maintenance
- 4WD drive skills
- Computer literate – word processing, spreadsheet
- High School Graduate, Community College (two-year degree) preferred (communication etc.)

To lead a team

- Certified Pesticide Applicator (EQPB Certification)
- First Aid Certification
- Airport Operations Area vehicle operator's certification (takes two weeks).
- Driver's License
- Computer literate – spreadsheet and word processing
- GIS navigation and working knowledge (ability to use hand-held GPS unit, download data to a computer, etc.)
- Data Collection and entry
- Community College Graduate (computers etc.), bachelor's degree preferred

Management

- GIS (PALARIS)
- Resource and Financial planning BOA
- Analysis and reporting BOA

Training to be provided

- Mechanical spray unit use and maintenance (SPREP and/or USFS)
- Airport Operations Area vehicle operator's certification (takes two weeks).provided free of charge by Airport.
- Herbicide application and safety (BoA).
- Training in using the Pacific Region Weed Led Database Management System PRWLDMS. (SPREP)

RECORDKEEPING

k) What will we record?

By management unit

- Coverage (area in square meters of imperata, as well as density/coverage per square meter)
- Quantity of herbicide used per treatment (will decrease as imperata density decreases)
- Estimate coverage from square meter x percent weed coverage, or count number of plants x 0.1 square meter.
- Notes
- Photopoints – key locations in each management unit

l) What will we record with?

Data sheet in the field

Then entered into PRWLDMS database

Hand-held GPS unit for points and perimeters

m) What will happen to the data?

Reports generated from database to show reduction in coverage over time.

n) Where will it be stored and backed up?

Stored at BoA. Sent to PALARIS and SPREP regularly for backup davidm@sprep.org

3) MONITORING AND EVALUATION

a) What are we monitoring?

- The reduction in coverage of imperata per management unit
- Nearby savanna, roadside, and farm areas which are potentially subject to infestation

b) What are we evaluating?

The successful eradication of imperata (zero imperata plants for 3 years).

SUCCESS MEASURES (Key Performance Indicators)

c) What KPI's or measures are we going to use?

Reduction in coverage (square meters and density per square meter)

d) How will we achieve these measures?

From the database

e) Who will be responsible for doing these?

Field team to record on field sheets and typed into database. Team leader to summarize into regular reports to USFS.

EVALUATION of past efforts

f) Were we successful?

To date, not yet

g) If not why not?

- Irregularity in follow up operations,
- flight schedules,

- weather irregularities and
- inadequate equipment to perform the tasks in the windows dictated by the weather and other factors.

h) Can we improve?

- Fixed (yet flexible) schedule with cooperation from the Airport
- better equipment and herbicides.

REPORTING

Periodic progress reports

- Area treated
- Reduction in imperata coverage

We were / were not successful

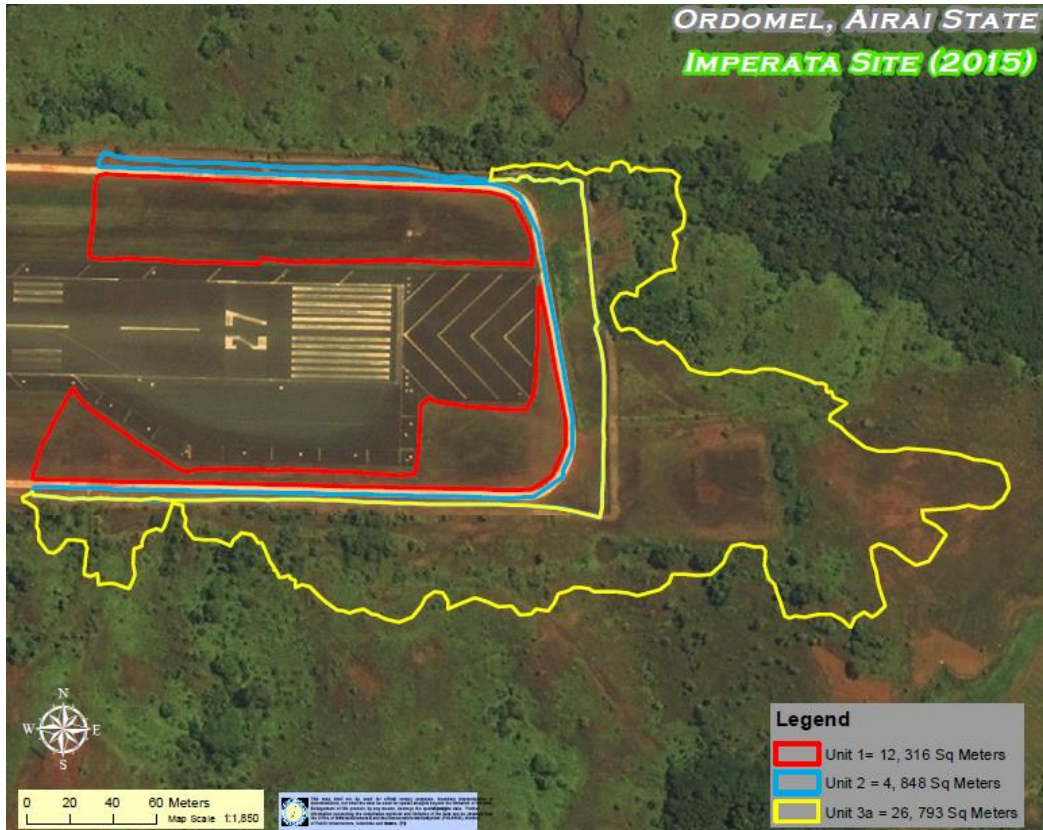
It would be good to have a timeline/matrix of activities. (Gantt chart?) This will be developed early in the project, once funding has been approved.

TIMELINE:

- Obtain funding
- Order equipment and supplies
- Disc MU1 (when equipment and supplies are on hand)
- Broadcast spray MU2, 3, and 4 (2-4 weeks)
- Broadcast spray MU1 (1 week)
- Check for regrowth/spot spray (2-4 weeks)
- Check for regrowth/spot spray (2-4 weeks)
- Hydroseed MU1 and 2
- Check for regrowth/spot spray
- Check for regrowth/spot spray

APPENDIX: Maps of Infestations

Site 1: Airport Runway Area



Site 2: Savanna SE of Runway



Site 3 (Management Unit 4), Melekeok

