Review of Information on Invasive Species and Results of IAS Survey

O le Pupu Pu'e National Park Restoration Project 2016-2020

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1. INTRODUCTION

This report was prepared for the Samoan Ministry of Natural Resources and Environment (MNRE) by consultant James Atherton with the assistance of Forestry Division Staff in particular Vailega Timoteo Molesi and Peteli Pese.

The O Le Pupū Pu'e National Park (OLPP) National Park is located approximately 15km south of Apia on the border of the districts of Falealili and Siumu (see Figure 1). It was the first national park to be established in the South Pacific and in Samoa. The original area of the O Le Pupū Pu'e National Park was about 4,234 hectares (10,457acres), but with the inclusion of the Togitogiga Forestry Plantation on the western edge of the park in 2008, as well as the recreational area at the Eastern edge, the Park increased to 5,019 hectares (12,396 acres) (MNRE 2010).

The purpose of the report is to summarise a review of existing information on the invasive species in the park and to present the results of a short survey of invasive species conducted in the park from Nov 19 to Dec 1, 2015. This report supports and complements a separate operational plan for the restoration of the OLPP National Park (Atherton 2015).

2. METHODOLOGY

The project involved two separate activities. First, a review of existing information, especially that related to the invasive species in the park. Second, a short survey of invasive species in the park focused on general observations as well as a survey of rodents.

2.1 Review of existing information on the park

A thorough reference list was prepared of all known reports on the National Park, especially those that cover biological data. Unfortunately, some key references could not be located, such as the main report of the UNDAT 1979 report (Ollier *et al* 1979). The results of the review are shown in chapter 3.

2.2 Survey of invasive species in the park

The survey of invasive species in the park was conducted between November 19 and December 1, 2015. It included two main components- a general observational survey of invasive species in the main vegetation zones in the park as well as a rodent survey. The field team was composed of Vailega Timoteo Molesi (FD), Peteli Pese (FD), Va'a Anoifale (DEC) and Kim Keleti (DEC). Figure 2 shows the location of the sites visited.

Component 1: General observational survey of invasive species in the main vegetation zones

The general observational survey of invasive species in the main vegetation zones was conducted to detect presence/absence of invasive species from the following major taxonomic groups:

- Invasive plants
- Invasive mammals (in particular rats, cats, pigs and cattle)
- Invasive birds (in particular myna birds, bulbul and jungle fowl)
- Insects – in particular Yellow Crazy Ants
- Molluscs- in particular Giant African Snail

Figure 1. Key Features of O le Pupu Pue National Park

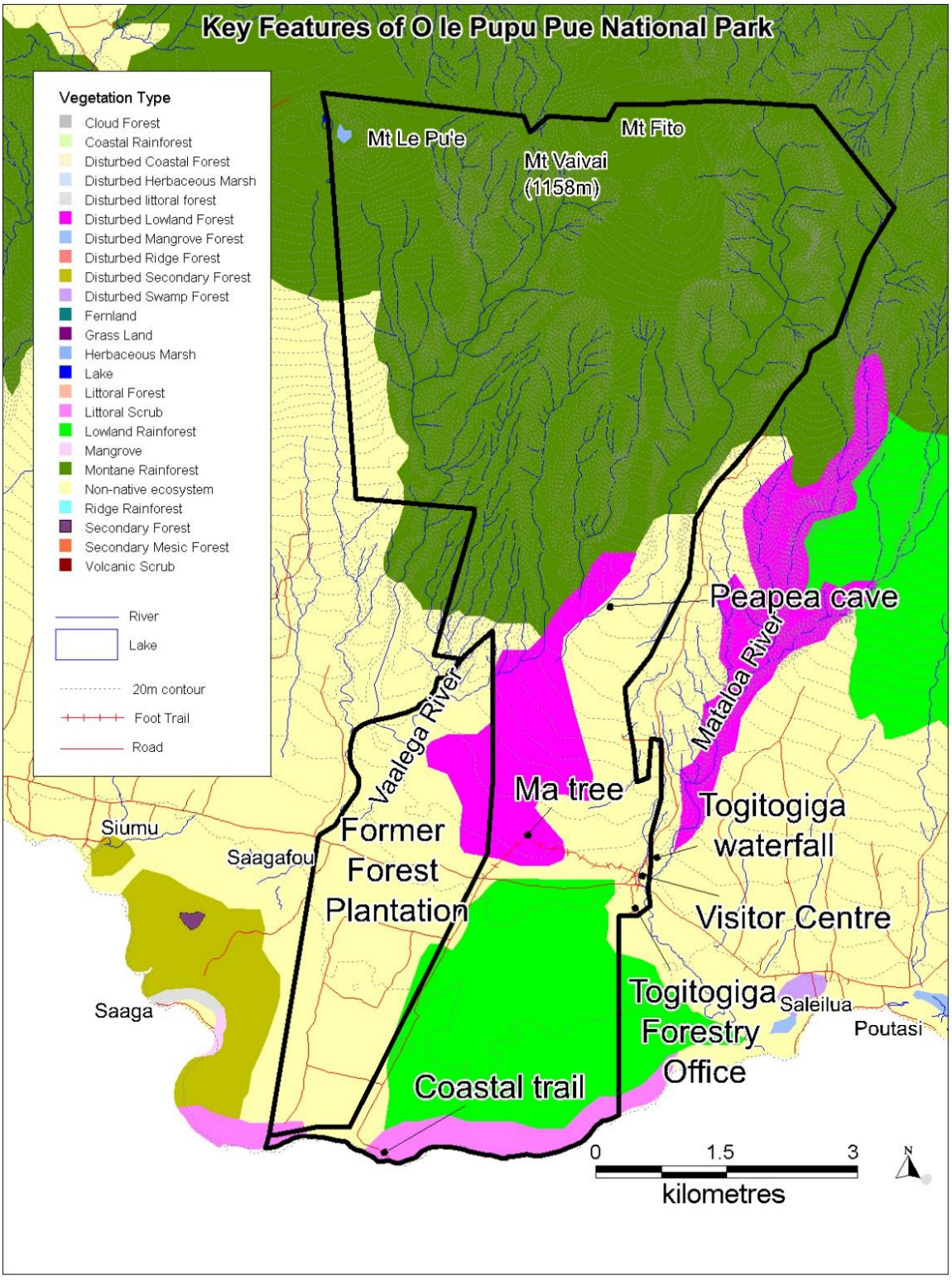
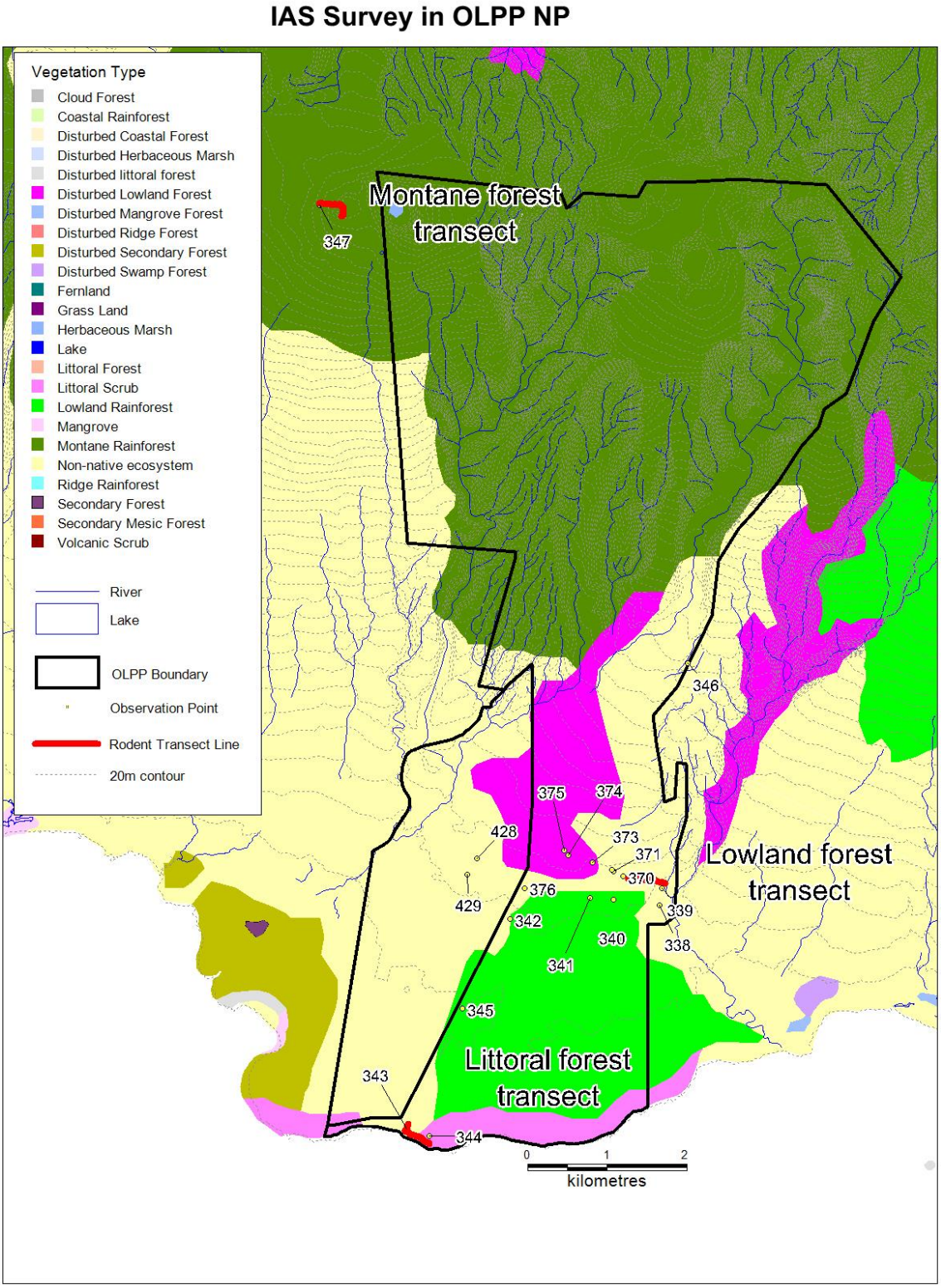


Figure 2. Sites visited as part of Invasive Species Survey of OLPP NP in 2015



The invasive species survey involved driving along roads and walking trails in each vegetation zone and conducting observations at sites that typify each vegetation zone. Suitable sites were identified in advance from satellite imagery and vegetation maps. The survey form used is shown in Annex 1.

For invasive fauna such as ants, rats, cats, pigs and cattle, active direct visual spotting as well as searching for indicator signs (e.g. signs of rat predation on fruits, scats, fresh tracks and excavated soil) was employed.

A summary of the results of the observational survey is provided in chapter 3, while the detailed spreadsheet of the findings of the general observational survey of invasive species are shown in Annex 2.

Component 2: Rodent Survey

In conjunction with the general survey, special techniques were also used to detect rodents following a similar approach to surveys used to study IAS at other sites in Samoa such as the recent IAS survey of the Aleipata islands (eg Sera and Tipamaa 2015). Rodents were selected for special study because little information was available on rodent distribution or species in the park.

The rodent survey was conducted in three main vegetation zones in the park (see figure 1):

- Littoral Forest
- Lowland Forest
- Montane Forest

At each site, twenty rat traps were placed along a transect every 25 metres, and marked with coloured flagging tape at each of the three sites and left for 7 nights.

At each station the following procedure was used: 1 snap trap with roasted coconut as bait set up in parallel with 1 sticky (glue) trap with same bait, at least one metre apart. Traps were set at chest height on trees, to avoid interference by crabs or pigs. The sixty rat stations were run for 7 nights from Nov 24 to 26.

On the second and third mornings the traps were checked again and bait replaced as needed. Unfortunately, due to a cyclone on day 4 (Friday) to 7 (Monday) it was not possible to check the traps. The traps were removed on day 8 (Tuesday December 1).

The rodent data log used for the 2015 Aleipata survey (Sera and Tipama'a 2015) was used (Annex 3). Identification of rats was based on the reference developed by Kiwicare.co.nz (http://www.kiwicare.co.nz/help/advice-pests-post/index.cfm/2011/09/identification-of-rats-and-mice/) as well as by PII (PII 2011).

A summary of the results of the rodent survey is shown in chapter 3 while the full results of the rodent survey are shown in Annex 4.

3. RESULTS

3.1.Summary of information sources on the park

There are a large number of information sources on the biological resources of the park and on surrounding areas. Many of these data sources also include information on invasive species. Table 1 is a summary of the main documents (published and unpublished), while Figure 3 shows the locations of historical surveys.

Table 1. Summary of key biological data sources on the OLPP National Park

Data source	Report Author	Survey Year	Location in park covered by survey	Data Coverage
Mapping *Merremia peltata* in O le Pupu Pue National Park: Recommendations for ecological restoration	Asia Air Survey 2014	2014	Survey of *M.peltata* done throughout the park	*Merremia peltata* (Fue lautetele)
Samoa Forest Cover Mapping and Inventory	SFD	2014	9 plots done in park (part of national coverage).	Vegetation – land cover/forest classification
Preliminary Bird Survey of O Le Pupū Pu'e National Park	Butler, D.J.	2009	Bird counts done throughout park	Birds
Vegetation Survey of O Le Pupū Pu'e National Park	Whistler, A	2008	8 vegetation plots in park	Flora
Butterfly investigation of O Le Pupu Pu'e and Mt Vaea protected areas.	Edwards, E	2008	Specimens collected on road to the coastal trail	Butterflies Moths
A preliminary survey of Samoan freshwater macro- faunal biodiversity	Jenkins, A *et al*	2008	Togitogiga – Mataloa river	Freshwater fauna
Recovery plan for Manumea or Tooth-Billed Pigeon (*Didunculus strigirostris*) 2006-2016 as well as Recovery Plan for the Ma'oma'o or Mao (*Gymnomyza samoensis*) Samoa's Large Forest Honeyeater 2006-2016.	MNRE	2006	Surveys done in in lowland forest near Ma tree	Birds
Samoa Forest Cover Mapping and Inventory	FAO/MNRE	2005	22 plots done in park (part of national coverage).	Vegetation – land cover/forest classification
The Conservation of Biological Diversity in upland ecosystems of Samoa	Schuster, C *et al*	1996	Mt Fito, Mt Le Pu'e and also near Togitogiga cattle ranch	Bats Birds Flora and vegetation Insects
Historical observations (1897 to 1994) collated as part of the Samoa Biodiversity Database (1994)- excel files only	MNRE	1994	Ad hoc observations in many parts of the park	Various but mostly plant and bird records
Terrestrial ecosystem mapping for Western Samoa	Pearsall, S.H. & Whistler, W.A	1991	Whole park (national coverage)	Vegetation (terrestrial ecosystems)
The National Survey of Western Samoa. The Conservation of Biological Diversity in the Coastal Lowlands of Western Samoa	Park, G *et al*	1990-1991	Surveys done in various parts of the park	Bats Birds Flora and vegetation
O le Pupu-Pu'e National Park, Samoa: Volume I– Main Report, United	Ollier, C.D., Whistler,	1979	Surveys done in various parts of the park	Vegetation Geology

Data source	Report Author	Survey Year	Location in park covered by survey	Data Coverage
Nations Development Advisory Team for the Pacific, Suva, Fiji.	W.A. and Amerson Jnr, A.B			
The forest resources of Western Samoa	Chandler, K.C., et al	1978 (revised 1990)	All (national coverage)	Vegetation – land cover/indigenous forest classification

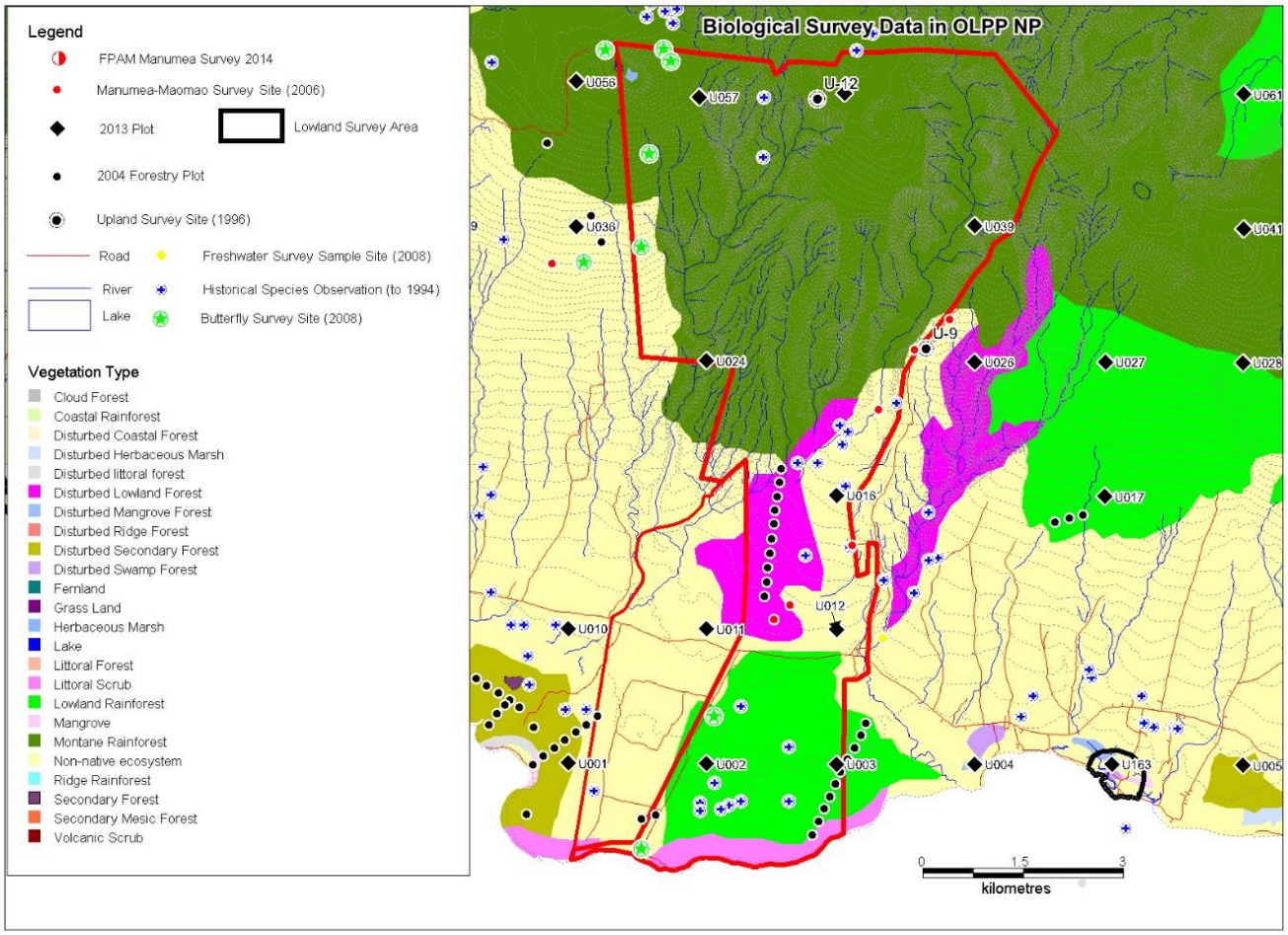


Figure 3. Map of Historical Biological Survey Data in OLPP NP

3.2 Summary of the results of the invasive species survey

A summary of the results of the invasive species survey are shown in table 2 below, by site visited.

Table 2. Summary of results of the invasive species survey

Site	WP Number	GPS - S	GPS -W	Elevation (m)	General Vegetation (Canopy)*	Disturbance by humans and cyclones and level of disturbance (H,M,L)	Invasive Plants Dominance (H, M, L)*	Invasive Animals	Other Comments
OLPP NP Visitor Centre	339	-14.0153	-171.721	48.04	In garden area = some ornamental trees; Niu, *Eucalyptus territicornis*, Teak, Talie, Tavai, Niu vao, *Ficus elastica*, Caribbean pine	High in garden area, lower in disturbed forest adjacent	Low, because managed area. Some Tamaligi paepae and *Clerdondrum quadriloculare*	Chickens	
OLPP NP on Main Coast Rd	341	-14.0164	-171.73	63.39	Lowland forest dominated by Tava	Medium (cyclones)	Overall low but Pulu vao stand (2 on north side, 30 plus on south side). Currently fruiting		
OLPP on road to coastal trail	342	-14.0188	-171.739	52.15	Lowland forest dominated by Tava	H (cyclones)	M, Losa Honolulu growing in area where row replanting with Talie and Malili occurring		
Coastal trail start	343	-14.0427	-171.751	29.81	Scrub with Lopa, Talie, Fetau and Fasa	H (cyclones)	L, some Fue lau tetele, Lopa, *Sphagneticola* along coast trail	YCA	
TV1 tower near coastal trail	344	-14.0435	-171.748	25.00	Fasa (*Pandanus*) scrub	H (cyclones)	L, some Togo Vao	Pig rooting, YCA	Bridled terns nesting on stacks offshore
Togitogiga cattle ranch fence with OLPP boundary	346	-13.9897	-171.718	247.80	Open Tava lowland forest with Mamalava, Tavai and Laufatu	M (cyclones)	M, Puluvao, Fue lau tetele, *Clidemia hirta*		
Mt Le Pue	347	-13.9376	-171.761	886.84	Open montane forest dominated by O'a with some Vivao and Pualulu (scattering of Tamaligi paepae)	H (cyclones)	H, Teine o le po, Tamaligi paepae		
Ma tree to car park	375	-14.011	-171.733	82.23	Tava, with Mamalava and a few large Ma trees	L at Ma tree, H in area (cyclones)	M (Koster's curse, Pulu mamoe at Ma tree car park with some Fue lautetele)		

Site	WP Number	GPS - S	GPS -W	Elevation (m)	General Vegetation (Canopy)*	Disturbance by humans and cyclones and level of disturbance (H,M,L)	Invasive Plants Dominance (H, M, L)*	Invasive Animals	Other Comments
Visitor Centre to Ma Tree trail	349	-14.0149	-171.721	130.81	Tavai dominant with Niu vao and Tava	M (cyclones)	L (Tamaligi paepae, Kosters curse, Pulu mamoe)	Chickens, YCA, Bubul, GAS shells	Open areas along trail dominated by Fue lautetele and Laupata (WP371 and WP 372). Koster's curse on trail. Many Pulu mamoe at WP370 and large Pulu mamoe at WP 373. Many Tava seedlings at WP374. Dead gata seen on trail- cut in half. YCA nests on trail
Togitogiga forestry plantation	428	-14.012	-171.743	63.70	Very open Mahogony plantation with Malili, Tamiligi (both species) and Tavai	M (cyclones)	M (Tamiligi both species, Pulu mamoe, Fue lautetele)	Cattle dung observed	In forestry plantation area. Some new plantings near road - Talie and Malili

* see Table 3 for scientific names of all species

3.3 Checklist of invasive species in the park

There are a large number of invasive species in the OLPP National Park from many different taxonomic groups. Information has been collected from all information sources for the following groups with the indicated level of completeness:

- Plants (fairly complete for Dicotyledons but not for Monocotyledons)
- Mammals (fairy complete)
- Birds (fairly complete)
- Invertebrates (highly incomplete)

A list of known invasive species from all sources that have been observed in the park is shown in Table 3 (plants) and Table 4 (animals) below. The tables list the scientific name, Samoan name and information source. Finally, for plants, if the origin of the plan is uncertain (ie whether it is native or introduced), it is indicated, as well as the survey plot that the plant was observed in the forest plots done in 2008 (Whistler 2008).

Table 3. Plant Invasive Species Observed in the OLPP NP

TAXONOMIC GROUP *Species*	Samoan Name	Information Source	Origin[1]	Presence in Whistler 2008 Plots
FERNS				
Pleocnemia irregularis (Presl) Holttum	----------	Whistler 2008	X?	1 2 3 4 0 0 0 0
MONOCOTS				
Commelina diffusa Burm. f.	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Cyperus pilosus Vahl	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Panicum maximum L.	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Paspalum conjugatum Bergius	vao lima	Whistler 2008	X	1 2 3 0 5 0 7 0
DICOTS				
Adenanthera pavonina L.	lopa	Whistler 2008	X	1 0 0 0 0 0 0 0
Albizia chinensis (Osb.) Merr.	tamaligi pa'epa'e	Whistler 2008	X	0 0 0 0 0 0 0 0
Alternanthera sessilis (L.) R. & S.	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Ardisia elliptica	Togovao	Whistler 2008	X	1 0 0 0 0 0 0 0
Blechum pyramidatum (Lam.) Urb.	----------	Whistler 2008	X	0 2 0 0 0 0 0 0
Castilla elastica Sessé	pulu vao	Whistler 2008	X	1 2 3 4 0 0 0 0
Centella asiatica (L.) Urb.	togotogo	Whistler 2008	X	0 0 0 0 0 0 0 0
Cestrum nocturnum L.	teine o le pō	Whistler 2008	X	0 0 0 4 5 6 7 8
Cinnamomum verum J.S. Presl	tigamoni	Whistler 2008	X	0 0 0 0 0 0 7 0
Clerodendrum chinense	Losa Honolulu	2015 survey	X	Not recorded in plot
Clerodendrum quadriloculare	Losa Fiti	2015 survey		Not recorded in plot
Clidemia hirta (L.) D. Don	----------	Whistler 2008	X	1 2 3 4 5 6 7 8
Crassocephalum crepidioides (Benth.)	vao mini	Whistler 2008	X	0 0 0 0 0 0 0 0
Cuphea carthagenensis (Jacq.) Macbr.	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Emilia sonchifolia (L.) DC.	pua lele	Whistler 2008	X	0 0 0 0 0 0 0 0
Endiandra elaeocarpa Gill.	----------	Whistler 2008	X	1 2 3 4 5 0 0 0

TAXONOMIC GROUP *Species*	Samoan Name	Information Source	Origin[1]	Presence in Whistler 2008 Plots
Erechtites valerianifolia (Wolf) DC.	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Funtumia elastica (Preuss) Stapf	pulu vao	Whistler 2008	X	1 2 3 4 0 0 0 0
Heritiera ornithocephala Kost.	mā	Whistler 2008	X?	0 2 3 4 0 0 0 0
Hyptis rhomboidea Mart. & Gal.	vao mini	Whistler 2008	X	0 2 0 0 0 0 0 0
Lantana camara L.	Latana	Whistler 2008	X	0 0 0 0 0 0 7 0
Ludwigia octovalvis (Jacq.) Raven	----------	Whistler 2008	X	0 0 0 0 0 0 0 0
Merremia peltata (L.) Merr.	fue lautetele	Whistler 2008	N?	1 2 3 0 0 0 0 0
Mikania micrantha H. B. K.	fue saina	Whistler 2008	X	1 2 3 4 5 6 7 8
Paraserianthes falcataria (L.) I. Nielsen	tamaligi ‘uli‘uli	Whistler 2008	X	0 0 0 0 0 0 0 0
Passiflora laurifolia L.	pasio vao	Whistler 2008	X	1 2 0 4 5 0 7 0
Spathodea campanulata	Faapasi	2015 survey	X	Not recorded in plot
Sphagneticola trilobata	----------	2015 survey	X	Not recorded in plot
Syzygium samarangense (Bl.) Merr. & Perry	nonu vao	Whistler 2008	X	1 2 3 4 5 6 7 0

Origin: X= Introduced. N = Native. ? = uncertain origin. Plot 1 at 50 m; Plot 2 at 235 m; Plot 3 at 375; Plot 4 at 500 m; Plot 5 at 750 m; Plot 6 at 865 m; Plot 7 at 930 m; and Plot 8 at 1000 m.

Table 4. Animal Invasive Species Observed in the OLPP NP

TAXONOMIC GROUP *Species*	Common Name	Samoan Name	Information Source	Location observed in park
MAMMALS				
Rattus exulans	Pacific Rat	Isumu	2015 survey	Highest numbers in the vicinity of Mt Le Pue
Sus scrofa	Feral pig	Pua’a	2015 survey	Signs of pig rooting seen throughout the park
Bos taurus	Cattle	Povi	2015 survey	Signs of cattle roaming in the vicinity of the park visitor centre and in former Togitogiga forest plantation
Felis catus	Feral cat	Pusi	MNRE 2010	Uncertain
Canis familiaris	Feral dog	Maile	MNRE 2010	Uncertain
BIRDS				
Acridotheres tristis	Jungle myna	Maina vao	Butler 2010, 2015 survey	Most commonly seen in disturbed areas and near the coast road
Acridotheres fuscus	Common myna	Maina fanua	Butler 2010, 2015 survey	Most commonly seen in disturbed areas and near the coast road
Gallus gallus domesticus	Chicken	Moa	2015 survey	Seen in disturbed areas such as near the park visitor centre
Pycnonotus cafer	Red vented bulbul	Manu palagi	Butler 2010, 2015 survey	Most commonly seen in disturbed areas and near the coast road
INVERTREBRATES				
Achatina fulica	African snail	Sisi Aferika	2015 survey	Most commonly seen in disturbed areas and near the main coast road
Anoplolepis gracilipes	Yellow Crazy Ant	Loi	2015 survey	Most commonly seen in disturbed areas and near the main coast road

4. IMPACTS OF INVASIVE SPECIES IN THE OLPP PARK

Our knowledge of the ecological impacts of many invasive species is limited. However, based on observations from within Samoa and also from other countries, the likely impacts of a few of the invasive species believed to have the greatest impacts on the biodiversity and ecosystem functioning of the park can be listed (Table 5). Impacts vary from direct impacts on consumed species, as is the case with many animal predators (such as rats and cats), to more indirect impacts on ecosystem functioning and species composition via competition or smothering of other plants (as is the case with many plant invasives).

Table 5. Estimated impacts of some invasive species on the biodiversity of the OLPP NP (adapted from Pierce *et al* 2012)

Invasive Species	High to severe impact on:
ANIMALS	
Pacific rat	Pigeons, terns, lizards, invertebrates
Feral cat	Pigeons, ground-nesting birds, boobies, terns
Feral pig	Seedlings, ferns, water retention of ground; nests of sea birds
Cattle	Seedlings, ferns, water retention of ground
Myna and bulbuls	High impact unlikely as these birds are restricted to disturbed areas
Yellow crazy ant	Ants and other invertebrates; people; land crabs, potentially many seabird species if ants reach high abundance particularly if scale insects are also present
Giant African Snail	Native snails? (perhaps via the *Platydemus manokwari* species used for biocontrol which also attack native snails)
PLANTS	
Merremia peltata and other invasive vines	High ecosystem impacts through smothering of native vegetation and restriction of seedling germination
Cestrum nocturnum	Potentially high ecosystem impacts through smothering and or outcompeting native species and also making trail development and maintenance difficult.
Invasive trees (eg *Albizia* and *Paraserianthes* species, African rubber, African tulip, Panama rubber tree etc)	Potentially high ecosystem impacts through outcompeting native plants and transforming ecosystems

5. RECOMMENDATIONS

The O le Pupu Pue National Park is highly invaded with invasive species from many different taxonomic groups including invasive plants, bids, mammals and invertebrates. The park is bordered on three sides by land and therefore the opportunity for re-invasions of any managed invasive species from surrounding areas is high. The three main types of active management of invasive species include prevention of entry, control and eradication.

Attempting to manage all the invasive species throughout the park will be an impossible task and consequently a prioritisation process needs to be followed to identify: a) the particular species that warrant some form of management and the type of management (control or eradication) needed as well as b) the particular areas within the park that warrant invasive species management.

5.1 Selecting Invasive Species for Management

It is proposed that the OLPP restoration plan focusses on the management of invasive species that fit the following three main criteria.

- Environmental/ecological impact of the invasive species in particular on threatened endemic species of on ecosystem functioning. *Priority to manage species with high ecological impacts.*
- Distribution and abundance of the invasive species in the park. *Priority to manage species with limited distribution and abundance, and especially those that are spreading.*
- Feasibility of management of the invasive species (eg costs, labour requirements, technical requirements for control methods). *Priority to manage species that are feasible to manage due to low cost, low labour and skill requirements, known management techniques, etc.*

Based on knowledge of these three main criteria, a preliminary prioritisation of invasive species for management in the park can be presented which includes the proposed management approach (control or eradication) (Table 6).

Table 6. Preliminary prioritisation of invasive species for management in the OLPP National Park

Invasive Species	Estimated Ecological impact	Distribution and abundance in the Park	Feasibility of management in the Park	Current Proposed Priority for management	Proposed management approach (control or eradication)
ANIMALS					
Pacific rat	High	Common and widespread	Probably high in small areas but not throughout the whole park	Low, but possible future priority in sensitive areas	-
Yellow crazy ants	Medium?	Common in disturbed areas at low elevations	Uncertain	Low	-
Feral cat	Medium	Unknown	Uncertain	Low, but possible future priority in sensitive areas	-
Feral pig	Medium	Common and widespread	Probably high in small areas but not throughout the whole park	Low, but possible future priority in sensitive areas	-
Cattle	Low?	Uncommon but occasionally enter from adjacent cattle farms	Probably high by erecting a secure boundary fence around the park	Low, but possible future priority in sensitive areas	Remove
Myna and bulbuls	Low?	Common in disturbed areas	Uncertain	Low	-
Giant African Snail	Low?	Common in disturbed areas at low elevations	Uncertain	Low. control method (*Platydemus manokwari)* likely to have greater impacts on native snails	
PLANTS					
Merremia peltata	Extreme	Abundant below 200m in open areas	Probably high in small areas	High	Control

Invasive Species	Estimated Ecological impact	Distribution and abundance in the Park	Feasibility of management in the Park	Current Proposed Priority for management	Proposed management approach (control or eradication)
Cestrum nocturnum	High	Abundant above 500m in open areas	Probably high in small areas	Medium	Control
Albizia chinensis and *Paraserianthes falcataria*	Medium	Widespread at all elevations	Probably high in small areas	Medium	Control
Funtumia elastica	Medium	Uncommon, restricted to lowland area	Probably high in small areas	Medium	Control
Castilla elastica	Medium	Uncommon, restricted to lowland area	Probably high in small areas	Medium	Control
Spathodea campanulata	Medium	Uncommon, restricted to lowland area	Probably high in small areas	Medium	Control

The species that is considered the highest current priority for invasive species management in the park at the current time is Fue Lautetele (*Merremia peltata*) because of the significant ecological impacts it is currently causing and the feasibility of management. Furthermore, management of Fue Lautetele is already underway in the park and techniques to manage it (physical removal and replanting with native species) are relatively low cost.

Future management of invasive animals, such as rats and cats in particular, may be warranted in particular sites in the park where for example a threatened bird such as Manumea or Maomao is being impacted.

5.1 Selecting Sites for Invasive Species Management in the Park

In National Parks and Reserves invasive species management often focuses on specific areas that are sensitive to invasive species and that have particularly important ecological values- such as critical or highly threatened habitats, or areas where threatened birds or other endemic species breed.

This review of existing knowledge of invasive species in the park did not identify particularly sensitive areas that are more important ecologically than other areas or where a threatened species is known to breed. Until such sensitive sites become known, site selection for invasive species management in the park should be based on practical factors such as ease of access and feasibility of management of the target invasive species. The OLPP National Park restoration plan goes into more detail on the proposed areas for management, as well as providing a proposed sequencing of the work in these areas.

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ANNEXES

Annex 1. Survey Form for General Observational Survey

Survey Data Sheet for OLPP IAS Survey- Nov 2015

Site Name:		
Surveyor's names:		
Date:	Time:	Weather:
Slope:	Lat:	Long:
Elevation (m):	WP #:	
Habitat type and canopy cover (trees >15m height) – species and dominance		
Sub canopy and shrubs (trees >1m < 15m height)- species and dominance		
Ground cover (<1m, <5cm dbh)- species and dominance		
Level of disturbance by cyclones or humans (H, M, L) and nature of disturbance		
Degree of invasion by invasive plants (H,M,L) and dominant invasive plants noted:		
Invasive animals noted (eg rats, cats, pigs, YCA, snails etc):		
Birds seen/heard:		

Other Indigenous biota	#species seen	Comment/spp./dominance etc
Insects (eg butterflies)		
Reptiles		
Flying foxes		
Other Comments		

Annex 2. Results of General Observational Survey

Site	*Surveyors*	*Date*	*Time*	*Weather*	*WP Number*	*GPS - S*	*GPS -W*	*Elev (m)*	*Slope*	*General Vegetation (Canopy)*	*Sub-canopy and shrubs*	*Ground cover*	*Disturbance by humans and cyclones and level of disturbance*	*Invasive Plants Dominance*	*Invasive Animals*	*Native Birds*	*Other Comments*
OLPP NP Visitor Centre	James, Timo,Peteli	19/11/ 2015	10.20	Partly cloudy	339	-14.0153	-171.721	48.04	Flat	In garden area = some ornamental trees; niu, Eucalyptus territicornis, Teak, Talie, Tavai, Niu vao, Ficus elastica, Caribbean pine	Nonu, plus planted fetau, ifiele and talie	Vaotuaniu and grass	H in garden area, lower in disturbed forest adjacent	Low, because managed area. Some A. falcataria and Clerdondrum quadriloculare	Chickens		
OLPP NP on Main Coast Rd	James, Timo,Peteli	19/11/ 2015	11.20	Partly cloudy	341	-14.0164	-171.73	63.39	Flat	Lowland forest dominated by Tava			M (cyclones)	Overall Low but pulu vao stand (2 on north side, 30 plus on south side). Currently fruiting			
OLPP on road to coastal trail	James, Timo,Peteli	19/11/ 2015	11.30	Partly cloudy	342	-14.0188	-171.739	52.14 555	Flat	Lowland forest dominated by Tava	Honolulu rose		H (cyclones)	M, Honolulu rose growing in area where row replanting with Talie and Malili occuring			19 staff work in the OLPP, including 13 field staff
Coastal trail start	James, Timo,Peteli	19/11/ 2015	11.50	Partly cloudy	343	-14.0427	-171.751	29.80 5443	Flat	Scrub with lopa, talie, fetau and Fasa	Littoral Scrub/Forest dominated by Fasa, but with some nonu, masame, laupata	Vaotuaniu and grass	H (cyclones)	L, some m.peltata, lopa, Wedelia along coast trail	YCA		
TV1 tower near coastal trail	James, Timo,Peteli	19/11/ 2015	12.30	Partly cloudy	344	-14.0435	-171.748	25.00 3941	Flat	Fasa scrub			H (cyclones)	L, some togo vao	Pig rooting, YCA		Bridled terns nesting on stacks offshore

Site	*Surveyors*	*Date*	*Time*	*Weather*	*WP Number*	*GPS - S*	*GPS -W*	*Elev (m)*	*Slope*	*General Vegetation (Canopy)*	*Sub-canopy and shrubs*	*Ground cover*	*Disturbance by humans and cyclones and level of disturbance*	*Invasive Plants Dominance*	*Invasive Animals*	*Native Birds*	*Other Comments*
Togitogiga cattle ranch fence with OLPP boundary	James, Timo,Peteli	19/11/ 2015	14.30	Partly cloudy	346	-13.9897	-171.718	247.7 9753 1	Slopin g to south	Open tava lowland forest with mamalava, tavai and laufatu	Puluvao, maota	Grass and m.peltata	M (cyclones)	M, Puluvao, M. peltata, Clidemia hirta			Fence fixed by MAF in 2014. Ruta works for MAF at the cattle farm (230 cattle and 92 sheep)
Mt Le Pue	James, Timo,Peteli	19/11/ 2015	16.00	Partly cloudy	347	-13.9376	-171.761	886.8 3874 5	Slopin g to north	Open montane forest dominated by o'a with some vivao and pualulu (scattering of Tamaligi paepae)	Olioli	Grass, Sedge, Koster's Curse	H (cyclones)	H, Cestrum nocturnum, A. falcataria			
Ma tree to car park	James,Vaa, Kim	24/11/ 2015	12.20	Cloudy, light rain	375	-14.011	-171.733	82.22 9492	Flat	Tava, with mamalava and a few large ma trees	Mamalava	Vaotuaniu and ti-vao	L at Ma tree, H in area (cyclones)	M (M.peltata, Koster's curse, Castilla at Ma tree car park with some fue lautetele)			
Visitor Centre to Ma Tree trail	James, Peteli, Timo, Kim, Vaa and 3 trail cutters	24/11/ 2015	9.50	Cloudy, light rain	349	-14.0149	-171.721	130.8 1468 2	Flat	Tavai dominant with niu vao and tava	Nonu, Niu, Asi toa	Vaotuanui, grass, Vao fefe	M (cyclones)	L (A. falcataria, Kosters curse, Castilla elastica)	Chickens, YCA, Bubul, GAS shells	Iao, Sega vao calling	Open areas along trail dominated by Merremia and laupata (eg WP371 and WP 372). Koster's curse on trail. Many Castilla at WP370 and large Castilla at WP 373. Many tava seedlings at WP374. Dead gata seen on trail- cut in

Site	*Surveyors*	*Date*	*Time*	*Weather*	*WP Number*	*GPS - S*	*GPS -W*	*Elev (m)*	*Slope*	*General Vegetation (Canopy)*	*Sub-canopy and shrubs*	*Ground cover*	*Disturbance by humans and cyclones and level of disturbance*	*Invasive Plants Dominance*	*Invasive Animals*	*Native Birds*	*Other Comments*
																	half. YCA nests on trail
Togitogiga forestry plantation	James, Peteli, Timo, Kim, Vaa	01/12/2015	1300.00	Cloudy	428	-14.012	-171.743	63.702	Flat	Very open mahogony plantation with Malili, Tamiligi (both species) and Tavai	Fau	Vaotuanui, grass	M (cyclones)	M (A. falcataria and chinensis, Castilla elastica, M. peltata)	Cattle dung		In forestry plantation area. Some new plantings near road talie and malili

Annex 3. Survey Form for Rodent Survey

SITE: WEATHER:
DATE: TIME: DATA COLLECTOR:

Station #	Waypoint	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	Notes

Annex 4. Results of the Rodent Survey

November 24, 2015

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
A1	378	-14.042172	-171.750864					YCA	
A2	379	-14.042365	-171.750978						
A3	380	-14.04258	-171.751017						
A4	381	-14.042794	-171.751122						
A5	382	-14.04294	-171.751282						
A6	383	-14.043028	-171.751128						
A7	384	-14.043027	-171.750968						
A8	385	-14.04321	-171.750769					YCA	
A9	386	-14.04335	-171.750655						
A10	387	-14.043416	-171.750409						
A11	388	-14.043433	-171.750177						
A12	389	-14.043543	-171.750009					YCA	
A13	420	-14.04361	-171.749785						
A14	391	-14.043689	-171.749522						
A15	392	-14.043815	-171.749348						
A16	393	-14.043853	-171.749235					YCA nest	
A17	394	-14.044069	-171.749074						
A18	395	-14.044177	-171.748808					YCA	
A19	396	-14.044295	-171.748591						
A20	397	-14.044397	-171.748401						
B1	350	-14.014705	-171.721031					YCA	
B2	351	-14.01468	-171.721241						

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
B3	352	-14.014638	-171.721531						
B4	353	-14.014574	-171.721746					YCA	
B5	354	-14.014487	-171.721921						
B6	355	-14.014397	-171.72211						
B7	356	-14.014267	-171.722377						
B8	357	-14.014251	-171.722672						
B9	358	-14.014292	-171.722903					YCA	
B10	359	-14.014384	-171.723122						
B11	418	-14.014383	-171.723314						
B12	419	-14.014284	-171.723523						
B13	362	-14.01416	-171.723758						
B14	363	-14.014124	-171.724049						
B15	364	-14.014208	-171.724268						
B16	365	-14.014289	-171.724534						
B17	366	-14.01422	-171.724739						
B18	367	-14.014258	-171.724908						
B19	368	-14.014288	-171.725209						Denser forest canopy
B20	369	-14.014211	-171.725383						Denser forest canopy
C1	398	-13.937389	-171.761315						
C2	399	-13.937376	-171.761131						
C3	400	-13.937428	-171.760804						
C4	401	-13.937466	-171.76059						
C5	402	-13.937482	-171.760362						
C6	403	-13.937471	-171.760227						

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
C7	404	-13.9375	-171.759927						
C8	405	-13.937523	-171.759705						
C9	406	-13.937506	-171.759494						
C10	407	-13.937525	-171.759238						
C11	408	-13.937483	-171.759007						
C12	409	-13.937548	-171.758869						
C13	410	-13.93771	-171.75875						
C14	411	-13.937755	-171.758592						
C15	412	-13.938163	-171.758566						
C16	413	-13.938163	-171.758566						
C17	414	-13.938336	-171.758602						
C18	415	-13.938556	-171.758526						
C19	416	-13.938709	-171.758622						
C20	417	-13.938814	-171.758792						

November 25, 2015

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
A1	378	-14.042172	-171.750864	N/S	Few insects				
A2	379	-14.042365	-171.750978	N/S	Few insects				
A3	380	-14.04258	-171.751017	N/S RB	2 pelagic gecko, 1 oceanic				
A4	381	-14.042794	-171.751122	N/S	Few insects				
A5	382	-14.04294	-171.751282	N/S RB	Few insects				
A6	383	-14.043028	-171.751128	N/S RB	Few insects				
A7	384	-14.043027	-171.750968	N/S	Few insects				
A8	385	-14.04321	-171.750769	N/S	Few insects				
A9	386	-14.04335	-171.750655	N/S RB	Few insects				
A10	387	-14.043416	-171.750409	N/S	Few insects				
A11	388	-14.043433	-171.750177	N/S RB	Few insects				
A12	389	-14.043543	-171.750009	N/S	Few insects				
A13	420	-14.04361	-171.749785	N/S RB	Few insects				
A14	391	-14.043689	-171.749522	N/S	Few insects				
A15	392	-14.043815	-171.749348	N/S RB	Few insects				
A16	393	-14.043853	-171.749235	N/S	Few insects				
A17	394	-14.044069	-171.749074	N/S	Few insects				
A18	395	-14.044177	-171.748808	Oceanic gecko (removed and trap reset)	Insects and spider				
A19	396	-14.044295	-171.748591		Few insects				
A20	397	-14.044397	-171.748401	N/S	Few insects				
B1	350	-14.014705	-171.721031	N/S	Few insects			YCA	
B2	351	-14.01468	-171.721241	N/S	Few insects				
B3	352	-14.014638	-171.721531	N/S	Few insects				
B4	353	-14.014574	-171.721746	N/S	Few insects				

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
B5	354	-14.014487	-171.721921	N/S	Few insects				
B6	355	-14.014397	-171.72211	N/S	Few insects				
B7	356	-14.014267	-171.722377	N/S	Few insects				
B8	357	-14.014251	-171.722672	N/S	Few insects				
B9	358	-14.014292	-171.722903	N/S	Few insects				
B10	359	-14.014384	-171.723122	N/S RB	Few insects				
B11	418	-14.014383	-171.723314	N/S	Few insects				
B12	419	-14.014284	-171.723523	N/S RB	Pelagic gecko removed				Cat spew. According to Peteli there are 2 wildcats in this area
B13	362	-14.01416	-171.723758	N/S	Few insects				
B14	363	-14.014124	-171.724049	N/S	Few insects				GAS Shell
B15	364	-14.014208	-171.724268	N/S RB	Few insects				
B16	365	-14.014289	-171.724534	N/S	Few insects				
B17	366	-14.01422	-171.724739	N/S RB	Few insects				
B18	367	-14.014258	-171.724908	N/S RB	Few insects				
B19	368	-14.014288	-171.725209	N/S RB	Few insects				
B20	369	-14.014211	-171.725383	N/S	Few insects				
C1	398	-13.937389	-171.761315	N/S					
C2	399	-13.937376	-171.761131	N/S					
C3	400	-13.937428	-171.760804	Pacific rat?	Lots of plant debris	Y			170mm HBL, 190mm tail
C4	401	-13.937466	-171.76059	Pacific rat?	1 moth skink, 1 blue tail skink	Y			120mm HBL, 130mm tail
C5	402	-13.937482	-171.760362	N/S	Few insects				
C6	403	-13.937471	-171.760227	Pacific rat?	Few insects	Y			170mm HBL, 180mm tail
C7	404	-13.9375	-171.759927	N/S	Few insects				

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
C8	405	-13.937523	-171.759705	N/S	Few insects				
C9	406	-13.937506	-171.759494	N/S	Few insects				
C10	407	-13.937525	-171.759238	N/S	Few insects				
C11	408	-13.937483	-171.759007	Pacific rat?	Few insects	Y			170mm HBL, 180mm tail; bulbuls in area
C12	409	-13.937548	-171.758869	N/S RB	Few insects				Cinammon trees in area
C13	410	-13.93771	-171.75875	N/S	Few insects				
C14	411	-13.937755	-171.758592	N/S	Few insects				
C15	412	-13.938163	-171.758566	N/S	Few insects				
C16	413	-13.938163	-171.758566	N/S	Few insects				
C17	414	-13.938336	-171.758602	N/S	Few insects				
C18	415	-13.938556	-171.758526	N/S	Few insects				
C19	416	-13.938709	-171.758622	N/S	Few insects				
C20	417	-13.938814	-171.758792	N/S	Few insects				
VC1	422	-14.014738	-171.720904	No snap trap, glue trap only					Glue trap only
VC2	422	-14.014738	-171.720904	No snap trap, glue trap only					Glue trap only
VC3	422	-14.014738	-171.720904	No snap trap, glue trap only					Glue trap only

Key: N/S= Not snapped; S = Snapped; BP =Bait present; NB = No Bait; RB= Replaced Bait

November 26, 2015

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
A1	378	-14.042172	-171.750864	N/S	RB				
A2	379	-14.042365	-171.750978	N/S					
A3	380	-14.04258	-171.751017	N/S					
A4	381	-14.042794	-171.751122	N/S					
A5	382	-14.04294	-171.751282	N/S					
A6	383	-14.043028	-171.751128	N/S					
A7	384	-14.043027	-171.750968	N/S					
A8	385	-14.04321	-171.750769	N/S					
A9	386	-14.04335	-171.750655	N/S					
A10	387	-14.043416	-171.750409	N/S					
A11	388	-14.043433	-171.750177	N/S					
A12	389	-14.043543	-171.750009	N/S					
A13	420	-14.04361	-171.749785	N/S					
A14	391	-14.043689	-171.749522	N/S					
A15	392	-14.043815	-171.749348	N/S					
A16	393	-14.043853	-171.749235	N/S					
A17	394	-14.044069	-171.749074	N/S					
A18	395	-14.044177	-171.748808	N/S					
A19	396	-14.044295	-171.748591	N/S					
A20	397	-14.044397	-171.748401	N/S					
B1	350	-14.014705	-171.721031	N/S RB	RB				
B2	351	-14.01468	-171.721241	N/S					
B3	352	-14.014638	-171.721531	N/S					
B4	353	-14.014574	-171.721746	N/S					

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
B5	354	-14.014487	-171.721921	N/S					
B6	355	-14.014397	-171.72211	N/S					Live GAS
B7	356	-14.014267	-171.722377	N/S					
B8	357	-14.014251	-171.722672	N/S					
B9	358	-14.014292	-171.722903	N/S					
B10	359	-14.014384	-171.723122	N/S					
B11	418	-14.014383	-171.723314	N/S					
B12	419	-14.014284	-171.723523	N/S					
B13	362	-14.01416	-171.723758	N/S					
B14	363	-14.014124	-171.724049	N/S					
B15	364	-14.014208	-171.724268	N/S					
B16	365	-14.014289	-171.724534	N/S					
B17	366	-14.01422	-171.724739	N/S					
B18	367	-14.014258	-171.724908	N/S					
B19	368	-14.014288	-171.725209	N/S					
B20	369	-14.014211	-171.725383	N/S					
VC1	422	-14.014738	-171.720904	No snap trap, glue trap only	Nothing				
VC2	422	-14.014738	-171.720904	No snap trap, glue trap only	Pelagic gecko				
VC3	422	-14.014738	-171.720904	No snap trap, glue trap only	Insects				

Key: N/S= Not snapped; S = Snapped; BP =Bait present; NB = No Bait; RB= Replaced Bait

November 27, 2015

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
B1	350	-14.014705	-171.721031	N/S					
B2	351	-14.01468	-171.721241	N/S					
B3	352	-14.014638	-171.721531	N/S					
B4	353	-14.014574	-171.721746	N/S					
B5	354	-14.014487	-171.721921	N/S					
B6	355	-14.014397	-171.72211	N/S					
B7	356	-14.014267	-171.722377	N/S					
B8	357	-14.014251	-171.722672	N/S					
B9	358	-14.014292	-171.722903	N/S					
B10	359	-14.014384	-171.723122	N/S					
B11	418	-14.014383	-171.723314	N/S					
B12	419	-14.014284	-171.723523	N/S					
B13	362	-14.01416	-171.723758	N/S					
B14	363	-14.014124	-171.724049	N/S					
B15	364	-14.014208	-171.724268	N/S					
B16	365	-14.014289	-171.724534	N/S					
B17	366	-14.01422	-171.724739	N/S					
B18	367	-14.014258	-171.724908	N/S					
B19	368	-14.014288	-171.725209	N/S					
B20	369	-14.014211	-171.725383	N/S					
VC1	422	-14.014738	-171.720904		Pacific Rat caught				HBL 120mm; Tail: 130mm; highly decomposed when seen on 30th Nov
VC2	422	-14.014738	-171.720904						
VC3	422	-14.014738	-171.720904						

Key: N/S= Not snapped; S = Snapped; BP =Bait present; NB = No Bait; RB= Replaced Bait

December 1, 2015

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
A1	378	-14.042172	-171.750864	N/S BP					
A2	379	-14.042365	-171.750978	N/S BP					
A3	380	-14.04258	-171.751017	N/S BP					
A4	381	-14.042794	-171.751122	N/S BP					
A5	382	-14.04294	-171.751282	N/S BP					
A6	383	-14.043028	-171.751128	S NB					
A7	384	-14.043027	-171.750968	N/S BP					
A8	385	-14.04321	-171.750769	N/S BP					
A9	386	-14.04335	-171.750655	N/S BP					
A10	387	-14.043416	-171.750409	N/S BP	Blue tail skink				
A11	388	-14.043433	-171.750177	N/S BP					
A12	389	-14.043543	-171.750009	N/S BP					
A13	420	-14.04361	-171.749785	N/S BP					
A14	391	-14.043689	-171.749522	N/S BP					
A15	392	-14.043815	-171.749348	N/S BP					
A16	393	-14.043853	-171.749235	N/S BP					
A17	394	-14.044069	-171.749074	N/S BP					
A18	395	-14.044177	-171.748808	N/S BP					
A19	396	-14.044295	-171.748591	N/S BP					
A20	397	-14.044397	-171.748401	N/S BP					
B1	350	-14.014705	-171.721031	N/S BP					
B2	351	-14.01468	-171.721241	S BP					
B3	352	-14.014638	-171.721531	N/S BP					
B4	353	-14.014574	-171.721746	S BP					
B5	354	-14.014487	-171.721921	N/S BP					3 live GAS
B6	355	-14.014397	-171.72211	N/S BP					
B7	356	-14.014267	-171.722377	S NB					
B8	357	-14.014251	-171.722672	N/S BP					

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
B9	358	-14.014292	-171.722903	N/S BP					Cattle dung
B10	359	-14.014384	-171.723122	N/S BP					
B11	418	-14.014383	-171.723314	S BP					
B12	419	-14.014284	-171.723523	S BP					
B13	362	-14.01416	-171.723758	N/S BP					
B14	363	-14.014124	-171.724049	N/S BP					
B15	364	-14.014208	-171.724268	N/S BP					
B16	365	-14.014289	-171.724534	Pac rat?		Y			Decomposed. HBL = 120mm;Tail =140mm
B17	366	-14.01422	-171.724739	N/S BP					
B18	367	-14.014258	-171.724908	S BP					
B19	368	-14.014288	-171.725209	N/S BP					
B20	369	-14.014211	-171.725383	N/S BP					
C1	398	-13.937389	-171.761315	Pac Rat?					Highly decomposed. HBL = 140mm; Tail 150mm
C2	399	-13.937376	-171.761131	Pac Rat?					Highly decomposed. HBL = 140mm; Tail 150mm
C3	400	-13.937428	-171.760804	S BP					
C4	401	-13.937466	-171.76059	S NB					
C5	402	-13.937482	-171.760362	N/S BP					
C6	403	-13.937471	-171.760227	N/S BP					
C7	404	-13.9375	-171.759927	N/S BP					
C8	405	-13.937523	-171.759705	S NB					
C9	406	-13.937506	-171.759494	N/S BP					
C10	407	-13.937525	-171.759238	S NB					
C11	408	-13.937483	-171.759007	S NB					
C12	409	-13.937548	-171.758869	Pac Rat?					Highly decomposed. HBL = 160mm; Tail 180mm
C13	410	-13.93771	-171.75875	S BP					
C14	411	-13.937755	-171.758592	S BP					

Station #	Waypoint	Latitude	Longitude	Status snap trap	Status sticky trap	Photograph taken (Y/N and ref. #)	Sample taken (Y/N and ref. #)	YCA presence	Notes
C15	412	-13.938163	-171.758566	N/S BP					
C16	413	-13.938163	-171.758566	N/S BP					
C17	414	-13.938336	-171.758602	N/S BP					
C18	415	-13.938556	-171.758526	N/S BP					
C19	416	-13.938709	-171.758622	Pac Rat?					Highly decomposed. HBL = 170mm; Tail 180mm
C20	417	-13.938814	-171.758792	N/S BP					
O1	423	-14.044071	-171.74865	N/S BP					NB- these 5 "O" traps were placed on the ground and left overnight on Nov 30
O2	424	-14.044133	-171.748664	N/S BP					
O3	425	-14.044249	-171.748677	S NB					Crabs taking bait?
O4	426	-14.04432	-171.748645	N/S NB					
O5	427	-14.044353	-171.748559	N/S BP					

Key: N/S= Not snapped; S = Snapped; BP =Bait present; NB = No Bait; RB= Replaced Bait