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INVASIVE ALIEN SPECIES SURVEY

ALEIPATA ISLANDS, SAMOA

SEPTEMBER-DECEMBER 2015

GEF-PAS Invasive Alien Species project/Samoa



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on behalf of the Ministry of Natural Resources and Environment (MNRE), Department of Environment and Conservation (DEC)



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Photo on the cover: Nu'utele island (Credit: G. Serra).

1. INTRODUCTION

Samoa is part of the Polynesia-Micronesia Biodiversity Hotspot, one of 34 regions of the world where extraordinary levels of biodiversity and endemism are coupled with extremely high levels of threat (Mittermeier *et al.* 2004).

The four Aleipata islands (Photo 1), holding a high percentage of representative and threatened species of Samoa, certainly represent a key site in the Polynesia-Micronesia biodiversity hotspot. In a 1986 review of 226 islands in the South Pacific region, these islands together rated 30th in importance for biological diversity (Vanderwoude *et al.* 2006). They were also more recently included in the list of the 7 Key Biodiversity Areas of Samoa (Conservation International *et al.* 2010).



Photo 1. Aerial image of the four islands of the Aleipata group: foreground on the left, Fanuatapu islet; next to the right, Namua island (almost at the center of the image). In the background, Nu'ulua (small to the left) and Nu'utele (larger to the right) (Photo: Stuart Chape).

Nu'utele and Nu'ulua islands, belonging to the Aleipata islands group, are the only uninhabited islands of the group large enough and far enough offshore to be considered as refuges for key native threatened biodiversity of Samoa (Butler *et al.* 2011). These two islands still hold highly pristine and sizable lowland rain forests (an ecosystem highly threatened all over the Western Pacific region) with almost null IAS occurrence.

In addition of being a refuge for several native and endemic bird species, these forests are home to the largest population in Samoa of a regionally threatened dove (Friendly Ground Dove *Alopecoenas stairi*) and to the elusive and critically endangered Tooth-billed Pigeon *Didunculus strigirostris*. The two islands host also the largest sea bird colonies in Samoa and the best nesting grounds nationally for the Hawksbill Turtle *Eretmochelys imbricata*.

The other two islands of the Aleipata group, Namua and Fanuatapu, are smaller in size and more easily accessible from Upolu, as they are located within the coral fringe (see Photo 1). Namua is forested and hosts a quite popular touristic resort. Fanuatapu, the smallest of the 4 islands (just a rocky islet), is uninhabited, covered by limited short-standing vegetation, and bearing a lighthouse.

Due to their size, forest coverage and remoteness, conservation work in the Aleipata islands during the past 15 years have focused on Nu'utele and Nu'ulua, and it culminated in a Critical Ecosystem Partnership Fund (CEPF) project that was implemented during period 2009-2010 [a partnership between the Secretariat of the Pacific Regional Environment Program (SPREP) and Conservation International; total budget ca. 220,000 USD; Tye 2012].

This project identified and recognized Polynesian rats *Rattus exulans*, Yellow crazy ant (YCA) *Anoplolepis gracilipes* and feral pigs *Sus scrofa* as the priority threats to the native biodiversity assets of these two islands (pigs only for Nu'utele). A review of past and recent Alien Species (IAS) management efforts in the Aleipata islands was recently compiled (Serra and Tipama'a 2016).

Three IAS field surveys of the Aleipata islands were organized by Maturu Paniani, national coordinator of GEF-PAS IAS project (a project run by MNRE/DEC in cooperation with SPRPE/United Nations Environment Program), during days 21-25 September, 26-30 October and 18 December 2015, as part of implementation of two activities of the workplan for Samoa (activities # 5 and 6).

Aim of the surveys was to survey current status of IAS on the four islands with a special focus on rats, YCA, pigs and weeds, and with a focus on the two larger islands, Nu'utele and Nu'ulua.

2. METHODOLOGY

2.1 NU'UTELE

Rats

Nine transect lines were established across Nu'utele island on days 22 and 23 September 2015 with the aim to cover most of its representative habitats, for a total of 100 rat trap stations (Maps 1a and 1b). Stations were spaced regularly, every ca. 50 m, and were marked with a coloured flagging tape. The transects covering the two slopes and the top ridge were in total ca. 3 km long. The parallel trap lines across Vini flats (ca. 0.7 km) and across Nu'utele flats (ca. 0.7 km) were similar and equivalent to those described by Butler (2010). The total transect coverage was therefore ca. 4.4 km.

At each station the following procedure was followed (as advised by Greg Sherley, *pers. comm.*): 1 snap trap with roasted coconut as bait was set up in parallel with 1 sticky (glue) trap with same bait. They were set up high on the ground at chest height on trees, to avoid interference by crabs. They were set up in the afternoon. At the end of each night the traps were checked, data and DNA rat samples were taken and baits replaced as needed (standard template of data log used is attached in Annex 1 as a reference). Sixty rat stations were run for three consecutive nights (22-25 Sept) while 40 were run for two nights (23-25 Sept).



Map 1a. Distribution of 100 rat trap stations across Nu'utele island as they were established during days 22 and 23 September 2015. Each station was made up of a snap trap and a sticky trap, both featuring roasted coconut as bait (Image: Google Earth).



Map 1b. Zooming of Fig. 1a (Image: Google Earth).

A spotlight night search was run on the first night soon after the arrival in Nu'utele aimed at detecting as many rats as possible, comprehensively covering- the so called Vini flats and partially the adjacent slope.

Any sign for rat occurrence was searched during day and night (e.g. fallen fruits with fresh signs of chewing, fresh tracks and scats etc.). Identification of rats was made based on specific reference developed by Kiwicare.co.nz (<http://www.kiwicare.co.nz/help/advice-pests-post/index.cfm/2011/09/identification-of-rats-and-mice/>). Identification was based on the use of 6 different and independent parameters simultaneously, such as the ratio of tail /body length, the length and colouration of hind feet, the hair colouration of belly, shape of muzzle and the body fur colour. Samples of tails for DNA analysis were stored in ethanol -95%, as advised on the website of the Pacific Invasives Initiative.

Yellow Crazy Ants

As advised by Dr Ben Hoffman (*pers. comm.*; Hoffman, 2011) a visual search of the top soil and base of trees was undertaken to map the current distribution of occurrence of Yellow Crazy Ants (YCA). A team of 3 people walked for 20 m in parallel looking for presence of the ants on the top soil. The aim being to record and define the boundaries of infestation with a GPS.

Once YCA were detected a count of abundance was carried out by counting the number of ants on a 10x10cm laminated card positioned on the top soil over a fixed period of 30 sec. In the presence of nests abundance was not calculated as it was assumed to be maximum.

The detection and abundance assessment procedures were run once at each rat trap stations mentioned above and perpendicularly outside the transects for a length of 50 m, where access was possible.

Most of above survey work was done during the first expedition (22-25 September 2015) but a back-up survey was run one day during the second expedition as well (24 October 2015).

Other fauna (IAS and native)

Occurrence of pigs across the island was estimated while surveying rats and YCA. Active direct visual spotting and search for signs (e.g. scats and excavated soil) was employed. While surveying for rats and ants, high vigilance was maintained in order to detect any other IAS fauna through direct visual detection, hearing of specific calls and based on signs and scats.

In particular, special focus was held for Feral cat *Felis catus*, Jungle Fowl *Gallus gallus*, Common Myna *Acridotheres tristis*, Jungle Myna *Acridotheres fuscus*, Bulbul *Pycnonotus cafer* and Giant African Snail *Achatina fulica* (IAS Samoa database).

Occurrence of key biodiversity species was attempted visually and based on calls, opportunistically, while running rat and YCA work. With a special emphasis on rare species such as the Friendly Ground Dove, the Samoan White Eye *Zosterops samoensis*, the Tooth-billed Pigeon and burrow-nesting sea bird-s during night surveying (petrels and shearwaters).

An estimate of numbers of individuals of the Friendly Ground Dove was attempted on 24 September and on 28 October 2015 as described in Butler (2010 and 2011). Sand beaches were checked for tracks of nesting turtles and surrounding ocean scanned for marine life.

Flora (IAS and native)

The forest team measured 200 meter intervals from the start of the trail at Vini flats to Nu'utele flats (please refer to Maps. 1a and b: plots were located on the same track used for rat sampling, but spaced 200 m instead than 50 m). Selected trees were measured within the 20x20m plots for checking tree growth and- photo points were taken at intervals that were identified in the past surveys by Foliga *et al.* 2007. The surveyors plotted out the areas on the map (using the GPS coordinates given) and marked it with flagging tape. They then measured the diameter at breast height for key species present (those that had been identified in the report) and conduct comparison for tree growth and tree volume.

Identification of new growing tree and forest species were recorded, including, fruits, flowers and birds feeding on these trees. The distance was measured and recorded, to contrast the growth patterns of forest to the elevation of the island. A reconnaissance survey was conducted along the baseline, recording the different forest species present, with special focus on IAS trees. This assisted with calculating the vegetation types and forest trees, from lower elevation, mid-slope and upper elevation of the island.

IAS weeds were surveyed at Vini and Nu'utele flats covering as much ground as possible.

2.2 NU'ULUA

The access by boat to Nu'ulua was confirmed to be highly difficult and risky especially with the trade winds on (the trade winds season runs from March-April to November). Two boats were involved: a local fishing aluminium catamaran and an aluminium dinghy from MNRE/Marine Division. Sea and wind forecasts were not consulted beforehand. First landing was achieved on the morning of 27 October despite the rough sea and strong wind. The return to the fishing boat 4 hours later, with low tide, was even more complicated and riskier.

Forty-three sticky traps were laid down on that same day covering a good portion of the island's surface and most habitat types (Map 2). Roasted coconut as bait was used as for Nu'utele. The same rat trapping design adopted in Nu'utele could not be replicated in Nu'ulua because the snap traps had not been included in the luggage brought from Apia (as it was discovered on landing in Nu'ulua). While laying the sticky traps, occurrence and abundance of YCA was assessed, using method explained for Nu'utele (see point 2.2), together with occurrence of key fauna and flora (IAS and native).

Two days later, on 29 October 2015 (with better sea conditions), all trap stations were checked for rat signs. Thirty traps (those whose baits had not been disturbed by crabs) were left in place. A survey to check the 30 traps was organized for 5 December 2015, aimed at increasing the number of trap-nights, but it had to be cancelled at the last minute due to the suddenly worsened sea conditions (i.e. big swells coming from north and south).

Another one-day survey was organized on 18 December and successfully implemented with the aim to check the 30 sticky traps left on 29 October (Young, 2015).



Map 2. Locations of forty-three sticky rat traps laid down across Nu'ulua on 26 October 2015 and associated sites of YCA assessment (Image: Google Earth).

2.3 NAMUA

On 29 October 2015 IAS surveys (fauna and flora) were run on Namua using the track shown in Map 3. YCA were searched using method explained for Nu'utele (point 2.2.). Visual detections of rats and birds were attempted. The owner of the resort Mr Ieti, from the family to which the island belong to, was interviewed on the same day.



Map 3. In blue, the track followed on 29 October 2015 across Namua island. Red cross: location of roost of fruit bats *Pteropus tonganus* (Image: Google Earth).

2.4 FANUATAPU

Twenty rat sticky traps were laid down on 28 October 2015 on Fanuatapu with the aim to cover as much ground as possible and all the available habitats (Maps 4a and b). Traps were checked two days later for rat signs, on 30 October 2015, when YCA were also searched using the same transect.



Map 4a. Islet of Fenuatapu (Image: Google Earth).



Map 4b. Locations of twenty rat sticky traps laid down across Fenuatapu on 28 October 2015 (Image: Google Earth).

2.5 BIOSECURITY

Informal biosecurity assessments were run at the time of boarding on the boats taking the various teams to the islands on the surveys run in September and October (for a total of 2 independent landings in each of the four islands, N=8). Attention was paid to ascertain whether MNRE staff or the locals would call for biosecurity checks of the luggage and of the equipment before boarding on the boat or at the time of landing on the islands.

2.6 TEAMS

Survey 21-25 September 2015

- Joe, Finni, Kim, Va'a, Fou from Terrestrial Team (MNRE/DEC)
- Paulo from Parks and Forestry (MNRE/DEC)
- Tasi and Pule, two local labourers from Lalomanu village district
- Faleafaga Toni Tipama'a (flora expert)
- Gianluca Serra (fauna expert).

MNRE staff were trained during the implementation of the field work. In particular Joe, Finni, Kim and Va'a assisted the fauna surveys and were trained in rat and YCA surveying while Tasi and Pule assisted the flora surveys and were trained in forest surveying.

Survey 26-30 October 2015

- Va'a from Terrestrial Team (MNRE/DEC)
- Kuata and Pule, two local labourers from Lalomanu village district
- Maturo Tapau (national coordinator GEF-PAS IAS project)
- Faleafaga Toni Tipama'a (flora expert)
- Gianluca Serra (fauna expert).

Survey 18 December 2015

- Va'a and Ta'alili from Terrestrial Team (MNRE/DEC)
- Maturo Tapau (national coordinator GEF-PAS IAS project)
- Stuart Young (biologist and ecologist).

2.7 SCHEDULES

Total duration of first survey had been originally planned to be 7 days from Monday to Sunday, but it was shortened to 5 days due to a series of logistical and organizational constraints.

21.9: Drive Apia-Lalomanu, boat to Nu'utele; arrival in Nu'utele ca. 15:00; camp established; G. Serra visited seabird cliff on W side of Vini beach at sunset on low tide; Joe and Kim checked the trail to the ridge before sunset; G. Serra led Paulo and Va'a in a 2-hour rat night search on Vini flats using spotlights.

22.9: G. Serra, Joe, Va'a, Kim and Finni established rat trap stations along the Vini slope to top ridge (10 stations), along the north and western ridge (20 stations), on the western slope to Nuutele bay (10 stations) and across Nu'utele flats (20 stations) . At same time occurrence of YCA and other IAS fauna were surveyed and recorded. Toni, Paulo and

two locals survey forest plots on the Vini slope towards the ridge, along the north and western ridge and along a path going down to Nu'utele flats; weeds were surveyed on Nu'utele flats.

23.9: Kim and Finni established another 14 rat trap stations along the path going down to Nu'utele bay (the one that was marked the day before by Toni) and checked the rat trap stations of previous day; Toni established 26 rat trap stations across Vini flats while surveying for IAS plants and weeds. Gianluca, Va'a and Joe estimated area of infestations of YCA on the ridge and checked the rat trap stations of previous day.

24.9: all together checking for rat traps (+ collection of rat DNA samples), searching for Friendly Ground Doves on Vini flats and searching for YCA (estimate of infestation areas).

25.9: split up in four teams to check and recover all rat trap stations and collect rat DNA samples; camp undone; boat to Lalomanu; drive back to Apia.

Second survey had been originally planned to last 5 days from Monday to Friday, but in the end the first day was spent in Apia due to organizational delays:

26.10: preparations in Apia including shopping, reached Namua after sunset.

27.10: first survey in Nu'ulua (rat traps laid down + YCA surveys)

28.10: first survey in Fanuatapu (rat traps laid down) + backup survey of YCA on Nu'utele

29.10: second survey to Nu'ulua (rat traps checked) + Namua IAS surveys

30.10: second survey in Fanuatapu (rat traps checked) + YCA surveys.

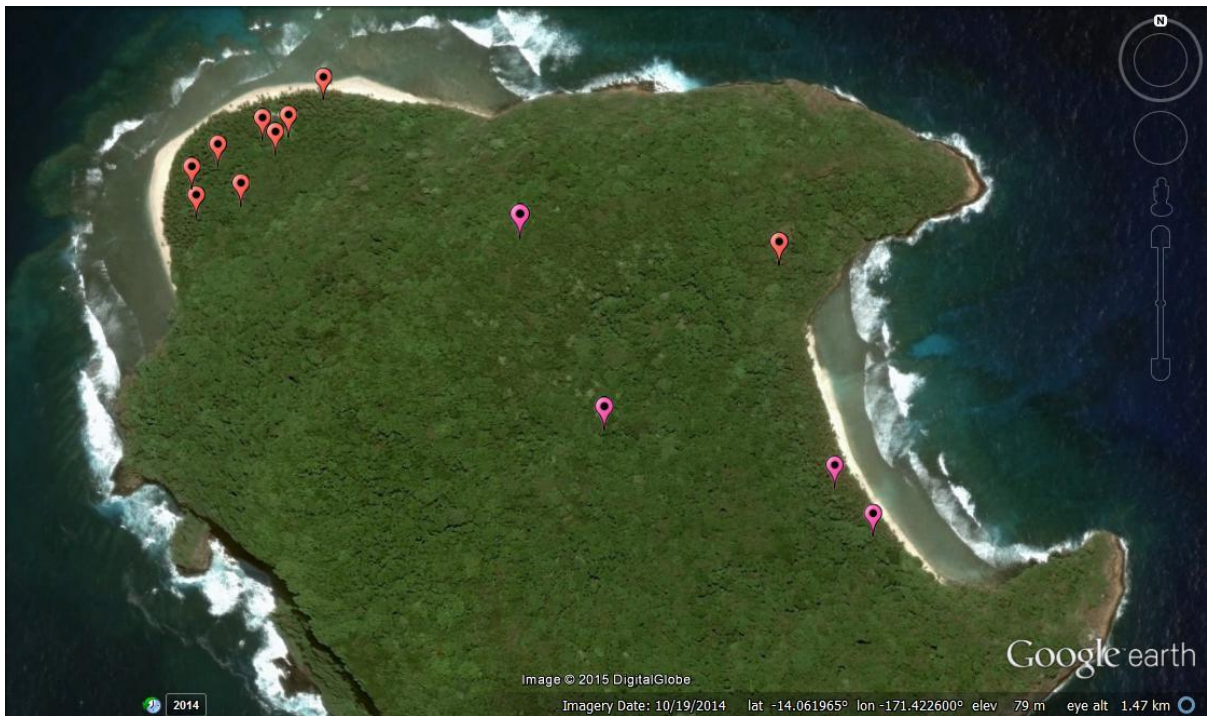
| Third survey aimed at Nu'ulua only -was run on 18 December from early morning to afternoon.

3. RESULTS

3.1 NU'UTELE

Fauna

| Rat trapping total effort was: 60 trap stations deployed for 3 nights = 180 trap nights; plus 40 trap stations deployed for 2 nights = 80 trap nights. In total therefore the trapping effort was 260 trap nights using two different types of traps. As a result, a total of 8 rats were caught in snap traps and one on a sticky trap (Map 5). Their tails were cut and stored for DNA analysis. Moreover, 4 instances of rat hair caught in the sticky traps were detected and recorded at four different trap stations (Map 5). Therefore, in total, we obtained 13 detections of rats through 260 trap nights.



Map 5. Rat detections in Nu'utele. Red tags: rats caught in snap traps (1 baby in sticky trap); Pink tags: rats hair found in sticky traps (Image: Google Earth).

All rats were identified as Polynesian rat. They were all adults except for a very young one caught on a sticky trap (head-body length= 50-60 mm). A total of six rats were detected at night using the spot light across Vini flats.

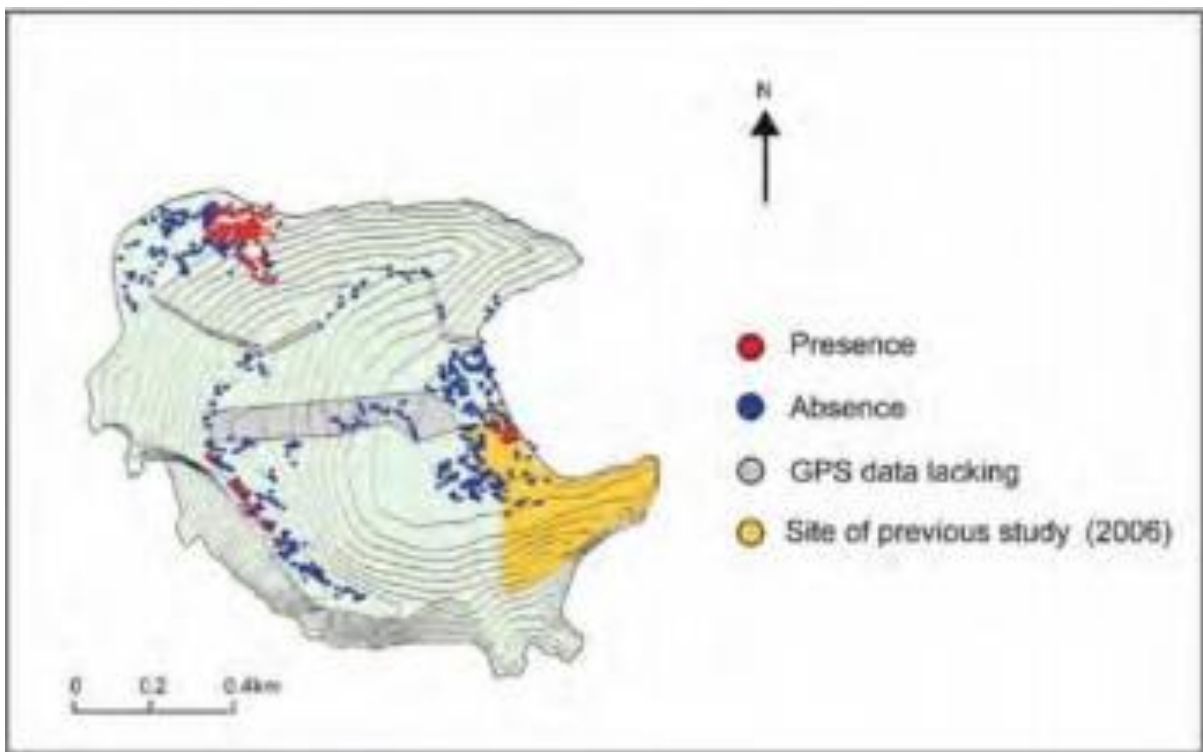
YCA were detected on Vini and Nu'utele flats only. Locations of their occurrence within Vini and Nu'utele flats is shown in Map 6a. Several nests were found on the ground below stones, inside old and empty coconut shells and at the base of trees on Vini flats.

Assessment of abundance was not undertaken in Nu'utele due to lack of time. YCA were not detected along the transect starting at Vini flats and reaching the top ridge, ~~or and also~~ along the two transects going down from the top ridge to Nu'utele flats.

We also did not detect their occurrence along the top ridge itself. On the top ridge several nests of *Camponotus* spp. ants were detected within dead log and branches. Interestingly, this species had not been detected on previous surveys by Hoffman (2011) (Hoffman, *pers. comm.*). Confusion ID between YCA and *Camponotus* spp. (that is also yellow in colouration) was avoided thanks to: i) samples collected and photographs taken, ii) *a posteriori* remote kind assistance by Dr Hoffman and iii) a back-up survey run on Nu'utele's top ridge on 28 October. As a term of reference, distribution of occurrence of YCA during previous surveys run by Dr Hoffman in 2009-2010 is shown in Map 6b.



Map 6a. Locations of YCA detections within Nu'utele island in September 2015 (Image: Google Earth).



Map 6b. Areas infested by YCA in 2009-10 (Map: Hoffman, 2011).



Photo 2. Polynesian rat caught in snap trap in Vini flats with YCA exploring the muzzle (Photo: Fou).



Photo 3. Coconut crab found on Vini flats during day-time (Photo: Toni).

Pigs were visually detected on several occasions during the day and evidence of their presence recorded (Map 7). In particular, a quite large female with piglets was seen at least in one instance.



Map 7. Locations of detections of pigs. Yellow tags: direct visual detections; Purple tags: signs of pig activity and occurrence (Image: Google Earth).

Notable recorded absence of key IAS animals that are common in Upolu were: Cockroach *Periplaneta americana*, Giant African Snail, Jungle Fowl, Common Myna, Jungle Myna, Red-vented Bulbul, Feral cat, and dog *Canis lupus*. Apparently the Jungle Fowl had survived the rat eradication in 2009 (A. Tye, *pers. comm.*) but it vanished in the following years due to unknown reasons (possibly eradicated by locals).

Birds detected and identified during the survey are listed in Annex 3. An estimated 5-6 Friendly Ground Doves were detected during a half an hour early morning count on the eastern side of Vini flats on 24 September 2015 (i.e. about a third of the total Vini flats area was covered). Six-seven individuals of the same species were detected between 7.15 and 8.15 on 28 October 2015 (2 definite males) within the whole extension of Vini flats – no rings were seen.

Substantial numbers of sea birds are confirmed to be nesting across the forest of Nu'utele and especially at its NW/W large sheer cliff. Dominant species were the Red-footed and Brown Booby *Sula sula* and *S. leucogaster*, Brown Noddy *Anous stolidus* and White Terns *Gygis alba*. Ca. 100 Brown Noddies were counted in association to a small vertical rocky cliff east of Vini beach during the October expedition. Few Black Noddies *Anous minutus* were recorded as well. Greater Frigatebird *Fregata minor* were seen passing by especially in the evening most likely directed to Nu'ulua. At least one Lesser Frigatebird *Fregata ariel* was intercepted and identified.

Possible detection of call of Manumea (Tooth-billed Pigeon) took place twice on Nu'utele: i) on 25 September, early morning, at the beginning of the trail starting from Vini flats and heading up to the top ridge: the "coo" call was heard twice with a time lapse of 7-8 sec; ii) on 28 October, coo call was heard repeated for 13 times in a row with frequency 10-15 sec. during first 10 repetitions (while time lapse increased to 20-25 sec. during the last three repetitions).

This latter call was heard within the patch of 15-20 maota trees *Dysoxylum samoensis*, the principal source of food for this critically endangered bird, in the middle of Vini flats (no fruits observed). Several fruiting maota were instead detected on Vini flats and also scattered elsewhere within the forest during the first expedition to Nu'utele, in September.

Notable bird absences recorded, consistently with previous surveys (Parrish and Sherley 2012): Masked Booby *Sula dactylatra* (seen at other times at sea within Aleipata islands range during previous years; reported to breed only on Rose Atoll, American Samoa, Biechle, *pers. comm.*), Samoan Fruit-dove *Ptilinopus fasciatus* (most common dove in Samoa, usually present in forested areas with many fruiting trees), Blue-crowned Lory *Vini australis*, Samoan Fantail *Rhipidura nebulosi* (common in the undergrowth of forests and at the edge of forests but "rare on islands" according to Parrish and Sherley 2012), Red-headed Parrotfinch *Erythrura cyaneovirens*, Cardinal Honeyeater *Myzomela cardinalis*, Mao *Gymnomyza samoensis* (usually occurring in mature forests)

We did not detect also the White-throated Pigeon *Columba vitiensis* (usually common in forested areas) or the Samoan Triller *Lalage sharpie* that were detected during previous surveys (Parrish and Sherley 2012). Butterflies detected and identified are listed in Annex 4: they were all seen at the camp base on 24 September 2015 except for the Samoan vagrant that was also seen in the forest (in October).

Samoan fruitbat (*Pteropus samoensis*), endemic to Samoa and Fiji, was commonly and daily observed soaring over the forest during the day. Detections of *Pteropus tonganus* were made at dusk and night, involving individuals flying from Upolu. A freshwater prawn was detected on a small pond of a drying creek at one edge of Nu'utele flats in September.

Three separated tracks of turtles were observed in the sand on Nu'utele beach at the upper intertidal shore level on 22 September 2015. They were not too far apart (less than 80 m), so it could have been the same individual. Species identification was not possible. According to MNRE/Marine division staff only the critically endangered Hawksbill Turtle is nesting on Nu'utele beaches. A Hawksbill Turtle was in fact spotted and identified on 22 September over the reef in front of Vini beach and the same observation at an equivalent site was replicated on 28 October 2015.

Endangered Humpback whale *Megaptera novaeangliae* was observed once on each of the five days around Nu'utele during the September survey, both within the outer and the inner side (between Nu'utele and Upolu) around the island. A calf with mother and another accompanying adult was observed on 23 September, surrounded by at least 15 dolphins (most likely Long-snouted spinner dolphins *Stenella longirostris*). A mother and calf were seen again between Nu'utele and Upolu on the evening of 28 October 2015. A pod of unidentified dolphins was observed on 22 September and also on 27 October between Nu'utele and Upolu.

Flora

Flora surveys resulted in no detection of IAS forest tree species nor IAS weeds, with the exceptions of one Lopa tree *Adenanthera pavonina* (listed under the Invasives Index List for Samoa – but still no broad consensus on its inclusion) and one individual of Tamaligi palagi (*Albizia* sp.) on Vini flats. This is the same individual detected by Foliga *et al.* (2007). The team conducted a ring barking process to kill this tamaligi tree (Photo 4).



Photo 4. Barking of tamaligi tree (Photo: Fou).

The forest of Nu'utele seemed pretty dry being the end of the dry season. The forest vegetation of the island- was found to be in good healthy state. Good undergrowth of native species was detected. Trees of *Diosporus* spp. (aoauli), *Syzygium clusiifolium* (asivai), *Sterculia fanahio* (fagaio) and *Dysoxylum* spp. (maota) were found fruiting.

A checklist of key forest tree species detected through the plots is reported in Annex 5.



Photo 5. Fruits of *Syzygium clusiifolium* (asivai) (Photo: Toni).

3.2 NU'ULUA

Thirteen out of 43 sticky traps were found to be missing the bait during the check run on 29 October. These 13 traps did not have any rat hair but instead presented signs compatible with crab movements. These traps had been probably not placed sufficiently high and vertically on trees to avoid crab interference. The other 30 traps instead still had the bait

intact and did not have any sign of rat movement nor hair (30 traps x 2 nights = 60 trap nights). Only 20 of the 30 traps left were detected and recovered on 18 December (a cyclone touched lightly Samoa at the end of November) and were found devoid of any hair nor sign of rat. Assuming, conservatively, that the baits lasted at least another 10 days following the visit of 29 October (they have probably lasted more than this), total effort achieved was 20 traps x 10 nights = 200 trap nights. Overall, we obtained 260 trap nights in Nu'ulua using only one type of rat trap.

YCA were detected at 22 out of 43 stations (Map 8) with abundance ranging from 9 to 45 ants / 30 sec (on top of these estimates, five nests were detected). A Blue moon butterfly was observed. Seven Friendly Ground Doves were detected in 1 and a half hour spent in the forest on 29 October 2015 (four on the slope and on the top ridge and three within the flats).

Nu'ulua appears to host important numbers of breeding Brown Noddy, Greater Frigatebird and White Tern (on top of appreciable numbers of Red-footed and Brown Boobies). Frigatebirds and red-footed boobies were seen at nest on top of trees on the top ridge of this island. Ca. 80-100 Frigatebirds were seen soaring over the island on 27 October 2015, while ca. 50 Brown Noddies used the north-eastern rocky point of the island as a perch/roost on the same day.

A ca. 10-foot shark was seen while sailing towards the above mentioned rocky point, on the outer side of the island, in deep waters, ca. 80 m from the shore. A young coconut crab was detected on Nu'ulua flats during the day.

No IAS trees, commonly found in Upolu, were detected on Nu'ulua, such as the Tamaligi *Albizia* spp., *Latana Lantana* spp. and Faapisi (African tulip *Spathodea campanulata*). No sign of *Merremia* spp. and no sign of weeds was found. The native forest of Nu'ulua was found intact. The dominant tree on Nuulua is Pu'a vai *Hernandia nymphaeifolia*, and the same trees found fruiting in Nu'utele were also found fruiting in Nu'ulua. The matalafi *Psychotria* spp., Mati *Ficus tinctoria* and Fetau *Inocarpus* spp. were also found fruiting. The only common vine growing on the island is the Mile-a-minute *Milkania micrantha*.



Map 8. Locations of detections of YCA along the transect used for the rat trap stations across Nu'ulua, as assessed on 27 October 2015 (Map: Google Earth).

3.3. NAMUA

A Polynesian or black rat was observed in the late afternoon at mid-way of the top ridge trail not far from where the fruit bat roost is located (Map 3). At least one cat and two dogs occur at the resort by the beach. No YCA were found across the transect indicated in Map 3. Other key IAS apparently absent from this island are the [Giant African giant sSnail](#), the two myna species and the Bulbul.

Mr Ieti, the owner of the resort, confirmed the presence of rats on the island. He stated that neither [Fferal cats](#) are present in the forest nor [Ggiant African sSnails](#), nor mynas nor bulbuls. He mentioned the presence of cockroaches and of the Rhinoceros beetle *Oryctes rhinoceros* on island.

Namua hosts a roost of *Pteropus tonganus* (see Map 3, red cross) counting several hundred individuals at the very least. They depart at sunset directed toward Upolu to return at dawn. Twelve turtles and one ray were observed while sailing on a dinghy boat through the lagoon of Namua during a period of 30 minutes at mid tide on 29 October 2015.

Namua island's forest appears partially invaded by Tamaligi and *Merremia* spp. vine. The inhabited and cultivated fringe of the island holds taro, bananas, yams, breadfruit, coconuts, flowering plants and exotic plants and very little native trees. This island also has *Lantana* spp. an ornamental plant listed in the Samoa IAS index.

3.4 FANUATAPU

No hair of rat was detected on any of the 20 sticky traps set in Fanuatapu following two nights (for a total of 40 trap nights). No YCA was detected along the transect. A flock of ca. 80 Brown Noddies was observed soaring above the islet (together with few individuals of

both species of boobies). One large tern (probably a Crested Tern *Sterna bergii*) was spotted flying over this island on 30 October. A local surf guide mentioned that the waters in front of this islet, ocean side, are known to host sharks, in particular hammerheads.

Coconut grows on the island together with some patches of Taemanu (Wild banana) trees along the 150 steps to the lighthouse. Dominant trees on the island are Pu'a vai and Fau *Hibiscus tiliaceus*. No IAS weeds have been detected on the island.

3.5 TRAINING

MNRE staff involved in the three surveys received a substantial in-service training on rat and YCA surveying and on forest surveying.

3.6 BIOSECURITY ASSESSMENT

The call for biosecurity check of the vessel, luggage and equipment at the time of boat boarding while directed to the four islands of Aleipata was never heard/mentioned neither by the Government staff involved nor by the local people or the boat man during 8 different and independent occasions (N= 8).

This critical issue was mentioned at the time of landing on the islands by the experts involved and late biosecurity searches and checks were then run on the luggage, supplies and boat. As a result, several ants were found on the dinghy boat that landed on Nu'ulua on 27 October 2015 (they were killed one by one): most likely they had accessed the boat while it was kept at the MNRE parking place in Apia.

4. DISCUSSION

The surveys confirmed the persistence of the Polynesian rat on Nu'utele ~~island~~[Island](#) consistently with findings by Butler *et al.* 2011 and its absence in Nu'ulua consistently with findings by Fisher *et al.* (2012) and MNRE (2012).

The failure of the rat eradication attempt run in Nu'utele in August 2009 is therefore confirmed 6 years later. The disproportionate distribution of detections of rats in Vini and Nu'utele flats (77% over the total, N= 13) seems an indication of the rodent's attraction for the coconut grove habitat *versus* the native forest habitat, consistently with what found by Olson *et al.* (2006).

In fact, the high rate of capture of rats within Vini's coconut grove is also consistent with results by Stringer *et al.* (2003a, b), who accounted 87% of their total rat captures within the same habitat (N= 24). These authors, by using peanut butter *versus* roasted coconut baits during two different surveys in early 2000s, concluded that the Polynesian rat in Nu'utele prefers the coconut bait, differently from what had been observed for the same species in New Zealand. It has been actually suggested by several authors that Polynesian rats survive mainly on coconuts in uninhabited oceanic islands (Biechle, *pers. comm.*).

According to Aaron Shiels (APHIS/USDA, *pers. comm.*) the young rat captured on a sticky trap at Vini flats was an estimated 4-5 weeks old. This means that it was most likely born at some point between 17 and 24 August -2015. This is an evidence that rats ~~in~~[on](#) Nu'utele

breed in the second half of (a very) dry season. So the spread of rat toxin in 2009 may well have taken place right when rats were giving birth.

The rat trapping/survey design adopted for Nu'utele worked well with 13 detections out of 260 trap nights, and by using two easy and locally available trap types. This is important in terms of chances of replicability by MNRE staff in the future. Four MNRE staff (Joe, Finni, Kim and Va'a) should be able to replicate a thorough rat survey using this simple design in the future.

By setting traps on tree trunks at chest high, interference by crabs was avoided in Nu'utele (only a couple of crab interferences were recorded out of 260 trap nights). The same cannot be said about the survey in Nu'ulua, taken place a month later under high time pressure (due to the need to leave the island before the low tide came in). Due to this temporal constraint, traps were laid down paying less attention to the issue of the need to avoid the crab interference. On top of this a higher density of crabs in Nu'ulua *versus* Nu'utele may also occur. As a result 13 out of 43 baits were reached and removed by crabs in Nu'ulua.

The rat survey design in Nu'utele was prepared based on:

- past rat surveys in the Aleipata islands (Stringer *et al.* 2000 and 2003; Butler 2010; Butler 2011; Fisher *et al.* 2012) and the New Zealand's Department Of Conservation's reference Broome *et al.* (2014);
- advises and recommendations by Dr Greg Sherley and Mr Nialuga Evaimalo (Head of Terrestrial Division of MNRE/DEC), both involved in rat surveys on those same islands in the recent past.

As a term of reference, below are reported key details of past rat trapping efforts:

- 1) Stringer *et al.* (2003) - Nu'utele: 85 trap nights (two types of traps); Nu'ulua: 40 trap nights (two types);
- 2) Fisher *et al.* (2012) - Nu'utele: 375 trap nights (1 trap type); Nu'ulua: 44 trap nights (1 trap type);
- 3) Butler (2010) - Nu'utele: 316 trap nights (4 trap types).

For a full perspective and details on past rat trapping efforts refer to Annex 2.

Unfortunately, the trapping design used in Nu'utele, involving two trap types, could not be replicated in Nu'ulua one month later due to organization and logistical shortcomings. The outcome of this trapping attempt, using sticky traps only, should be evaluated in the light of the outcomes of previous 4 independent trapping surveys run following the 2009 eradication attempt:

- 1) August 2009: 44 sticky traps, well covering the whole island area, deployed for 1 night (44 trap nights): no rats detected (Fisher *et al.* 2012).
- 2) December 2009: 44 sticky traps, well covering the whole island area, deployed for 1 night (44 trap nights): no rats detected (Fisher *et al.* 2012).
- 3) August 2010: 44 sticky traps, well covering the whole island area, deployed for 1 night (44 trap nights): no rats detected (Fisher *et al.* 2012).

- 4) April 2012: 19 snap traps, covering mostly the flats of Nu'utele, deployed for 2 nights (38 trap nights): no rats detected (MNRE 2012).

The rat survey run in Nu'ulua between October and December 2015, with its total trapping effort of at least 260 trap nights (a conservative figure), represents the biggest effort of trapping run so far, following the eradication attempt of August 2009. The consistency of the outcomes of the five independent surveys run after the eradication attempt (including the most recent one), between 2009 and 2015, taken all together (two types of traps employed in total), appears as a quite robust evidence that the eradication operation in Nu'ulua had been successful.

As a reference, ca. 100 trap nights of sticky traps only, deployed within the eastern slopes of Nu'utele and within Nu'utele bay in September 2015, were sufficient to detect four rats. Moreover, David Butler caught one Pacific rat with a snap trap in 2004 in Nu'ulua over only one night, presumably using the same bait we used (Parrish *et al.* 2004). Based on the above mentioned two facts, if rats still occurred in Nu'ulua, 260 trap nights of sticky traps using roasted coconut as a bait should have been sufficient to detect at least one rat.

The occurrence of YCA on both Nu'utele and Nu'ulua was confirmed. The full invasion of Nu'ulua by YCA is confirmed (Vanderwoude *et al.* 2006). In Nu'utele YCA seem still limited to Vini and Nu'utele flats, while they are absent from the other sectors of the island that were sampled.

They seem to have expanded their distribution on both flats of Nu'utele. On the other hand they seem to not occur anymore on the top ridge as they used to do in 2009-10 (Hoffman 2011). Overall, 8 years after their first detection by MNRE, the invasion of Nu'utele by YCA seems "on hold". This outcome would be worth to be confirmed by a more focused survey covering more ground and time in Nu'utele.

Interestingly, both rats and YCA in Nu'utele seems still both confined to Vini and Nu'utele flats: an indication that a pretty large and pristine stretch of native forest like that of Nu'utele is a fully functional ecosystem offering limited opportunity for invasion by alien species, consistently with results by Olson *et al.* (2006) on rats and mongooses in Fiji. On the other hand, a small stretch of native forest like the one in Nu'ulua may be more vulnerable to invasions.

Sadly, the widespread occurrence of feral pigs in Nu'utele is also confirmed. They seem to be still in low density but worryingly they appear to be thriving and even breeding.

Present survey confirms that rats and YCA are absent from Fanuatapu (consistently with Fisher *et al.* 2012). It also confirms the occurrence of rats in Namua (Fisher *et al.* 2012). We did not find any YCA on this latter island, partially consistently to what found by Fisher *et al.* (2012) ("YCA are very rare on this island"). Probably they have vanished from this island since the time of the survey by Fisher *et al.* (2012).

The land bird community recorded in Nu'utele at this specific time of the year was consistent with communities found in equivalent ecosystems in Upolu, except for the notable rarity of Samoa Fruit-dove and for the apparent absence of White-throated Pigeon, Many-coloured Fruit-dove, Samoan Fantail, Red-headed Parrotfinch and Samoan Triller.

The parrotfinch was also not detected in Nu'utele during bird surveys in 2000-2001 and in 2010-2011, while the fantail was found to be "very rare" (Butler 2010 and 2011; Parrish and Sherley 2012). The absence of doves and the pigeon during present surveys may be linked to the very dry season found during the first survey (end of September), despite many trees were found to be fruiting.

The non-detection of other 3 forest bird species that are normally found in Upolu (Mao and to a lesser extent Blue-crowned Lory and Cardinal Honeyeater) is consistent with previous bird surveys mentioned (Butler 2010 and 2011; Parrish and Sherley 2012). Indications that the mysterious and extremely elusive, critically endangered, Manumea may still occur in Nu'utele seems confirmed by present surveys, consistently with the presence of its favourite fruiting tree (maota).

The Friendly Ground Dove counts at Vini flats (Nu'utele) during September and October surveys seemed consistent with figures reported by Butler (2011). It may be worth conducting a more detailed check in the short-term: the methodology used by previous surveys (e.g. Butler 2011) should be replicated in order to attempt to assess the trend of this valuable population over time.

Although counts were not undertaken, the current population sizes of sea birds (frigatebirds, noddies and boobies) seem consistent and equivalent with those mentioned by Butler (2011). A major colony of breeding frigatebirds is confirmed for Nu'ulua, consistently with previous surveys (Parrish and Sherley 2012). Flocks of dozens of Polynesian starlings *Aplonis tabuensis* were seen arriving at sunset to Nu'utele, coming from Upolu, on 24 September and also on 28 October.

Also some Pacific Pigeons *Ducula pacifica* were seen doing the same, one bird at a time, both in Nu'utele and in Namua. These observations together seem to confirm the important role as roosting site played by Nu'utele for forest birds occurring in Upolu (Parrish and Sherley 2012).

Overall, recorded avian diversity in Nu'utele and Nu'ulua (28 native species in total) and its conservation relevance (6 endemic species to Samoa and 2-1 globally threatened) is equivalent and consistent to what found in early 2000s by Parrish and Sherley (2012: 23-26 native species, 6-5 endemic, 2-1 globally threatened).

These two islands together should be considered as a key bird sanctuary of Samoa. And also a turtle sanctuary: present survey confirmed presence of critically endangered Hawksbill Turtle in the waters surrounding Nu'utele and on its beaches. The ocean surrounding these two islands seem still rich of marine life (whale, dolphins, sharks) confirming the ecotourism vocation of the Aleipata MPA.

Based on past reports, it is interesting to note that the Bulbul has probably made few attempts to colonize Nu'utele during the past 5-6 years (as mentioned above, most bird species are able to cross the 1.3 Km stretch of sea separating Upolu from Nu'utele) but failed most likely because they need to associate to people in order to survive. Same applies for the two species of mynas that have most likely tried the colonization of Nu'utele as well (although there is no record of this).

Nu'utele, Nu'ulua and Fanuatapu are still quite devoid of IAS flora (both trees and weeds). Abundance of good undergrowth of native species observed seems to show little disturbance from IAS animals in Nu'utele. No evident signs of negative effects of YCA on the forest were observed.

Comparison of the results of the previous forest survey by MNRE in Nu'utele (Foliga *et al.* 2007) with the present survey shows no detection of IAS plants in the mid-slope to upland slope of the island. Only one IAS tree individual detected in the lower-slope of the island (tamaligi), and no weed species detected. In particular, *Merremia* and *Wedelia* detected in 2007 were not detected during current survey.

Selected forest trees in the plots surveyed in 2007 in Nu'utele were re-measured in this survey and found to have grown in girth/size and height since then. The abundance of undergrowth seedlings evidence a remarkable forest regeneration.

Unfortunately, present surveys confirm that the complete lack of biosecurity is still threatening the biodiversity and ecosystems of these islands. Addressing this key threat, by reviving the interest and participation of the local community, seems currently the priority number one for the Aleipata islands, together with the eradication of pigs from Nu'utele [that had been recommended the first time in 2006 (IEAG 2006)].

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ANNEX 2

PREVIOUS RAT SURVEYS IN NU'UTELE AND NU'ULUA

<i>Survey/author/date</i>	<i>Island</i>	<i>Coverage</i>	<i>N. trap nights</i>	<i>N. and type of traps</i>	<i>Type of bait</i>	<i>N. rats caught</i>
Stringer et al. 2000	Nu'utele	Cross island trail (every 50 m)	102 or 36.5 snap traps + 44 tunnel nights?	Snap + tunnels	Roasted coconut and peanut butter	1
	Nu'ulua	Circle trail (described by Fisher 2012), every 7-10 m	120	Snap	Roasted coconut and peanut butter	0
Stringer et al. 2003	Nu'utele	Cross island trail (every 50 m) + 3 lines on Vini beach	85	Snap + tunnels	Roasted coconut	24 (21 on Vini)
	Nu'ulua	Circle trail (described by Fisher 2012)	40	Snap	Roasted coconut	0
Foliga et al. 2007 (September)	Nu'utele	Cross island trail from Vini to Nuutele beach	90	Snap and wax (both worked the same)	?	13
Fisher Jun 2009, Dec 2009, Aug 2010	Nu'utele	Ridge, Vini and Nuutele beach	375	Glue	?	26, 0, 0
	Nu'ulua	Nuulua beach and ridge	44x3	Glue	?	
Butler 2010 (March)	Nu'utele	Vini and Nu'utele Beaches, up the hill from Vini beach and on three lines from the top of the hill to Nu'utele Beach (down the centre along the bird transect, and around cliffs on each side)	316	Snap + tunnels +wax tags + tomahawk	Roasted coconut	0
Butler 2011	Nu'utele	Similar to above	?	?	?	10
MNRE/Stowers et al. 2013	Nu'utele	Trail from Vini to ridge	26	Snap	Roasted coconut	0

ANNEX 3
BIRD CHECKLIST

#	Species common and scientific names	Notes*
1	White-tailed Tropicbird <i>Phaethon lepturus</i>	Seen once
2	Brown Booby <i>Sula leucogaster</i>	Common and breeding
3	Red-footed Booby <i>Sula sula</i>	Common and breeding, chicks seen both in September and October
4	Great Frigatebird <i>Fregata minor</i>	Breeding in Nu'ulua. Seen a congregation of 80-100 individuals soaring over the island on 27 October
5	Lesser Frigatebird <i>Fregata ariel</i>	Identified at least one time from Nu'utele
6	Reef Heron <i>Egretta sacra</i>	Seen once
7	Banded Rail <i>Gallirallus philippensis</i>	Heard once in Nu'utele in September and seen by Toni in Nu'ulua in October
8	Far Eastern Curlew <i>Numenius madagascariensis</i>	Seen twice on the beach of Nu'ulua in October
9	Pacific Golden Plover <i>Pluvialis fulva</i>	Seen one individual on the rocky intertidal
10	Wandering Tattler <i>Heteroscelus incanus</i>	
11	Ruddy Turnstone <i>Arenaria interpres</i>	Several seen on the intertidal rocks in Nu'ulua
12	Blue Noddy <i>Procelsterna cerulean</i>	Probably breeding
13	Brown Noddy <i>Anous stolidus</i>	Common and probably breeding
14	Black Noddy <i>Anous minutus</i>	Uncommon
15	White Tern <i>Gygis alba</i>	Common and probably breeding
16	Friendly Ground Dove <i>Alopecoenas stairi</i>	Listed as Vulnerable by the IUCN Red List. Counted 5-6 during 30 min search on Vini flats in September (a third of flats was covered), and 6-7 in October across all Vini flats. They were seen also along the slope

		from Vini to the top ridge and on Nu'utele flats.
17	Pacific Pigeon <i>Ducula pacifica</i>	Common
18	Tooth-billed Pigeon <i>Didunculus strigirostris</i>	Possibly heard twice in both September and October. Endemic to Samoa, listed as Critically Endangered by the IUCN Red List
19	Samoaan Fruit-dove, <i>Ptilinopus fasciatus</i>	Only heard once
20	White-rumped Swiftlet <i>Aerodramus spodiopygius</i>	Common and most probably breeding
21	Flat-billed Kingfisher <i>Todirhamphus recurvirostris</i>	Common, endemic to Samoa
22	Polynesian Starling <i>Aplonis tabuensis</i>	Common
23	Samoaan Starling <i>Aplonis atrifusca</i>	Abundant, endemic to Samoa
24	Scarlet Robin <i>Petroica multicolor</i>	Probably heard few times
25	Samoaan Broadbill <i>Myiagra albiventris</i>	Endemic to Samoa. Heard and seen few times, indication of breeding in October
26	Polynesian Triller <i>Lalage maculosa</i>	
27	Samoaan Whistler <i>Pachycephala flavifrons</i>	Heard and seen several times, endemic to Samoa
28	Wattled Honeyeater <i>Foulehaio carunculata</i>	Abundant, most common bird in both islands

(*) If not mentioned explicitly, identification was definite. Possible additional sightings and identifications mentioned by team staff (unconfirmed) are the following: Samoaan Fantail and Samoaan Triller.

ANNEX 4

DIURNAL BUTTERFLY CHECKLIST

#	<i>Species common and scientific names</i>	<i>Notes</i>
1	Grass yellow <i>Eurema hecabe sulphurata</i>	
2	Monarch <i>Danaus plexippus</i>	
3	Blue moon <i>Hypolimnas bolinas pallescens</i>	
4	Samoaan eggfly <i>Hypolimnas errabunda</i>	Endemic to Samoa
5	Common vagrant <i>Vagrans egista bowdenia</i>	
6	Samoaan cerulean <i>Jamides argentina</i>	

ANNEX 5

CHECKLIST OF KEY FOREST TREES

Local Name	Scientific name	Plot # /Distance	Elevation (m asl)	Number of trees	Comments
Fuafua	<i>Kleinhovia hospita</i>	075/0	44	5	very common tree in the lower slopes
Tavai	<i>Rhus taitensis</i>			2	Common tree from lower slopes to the upland slopes
Atone	<i>Myristica inutilis</i>			7	
'Au'auli	<i>Diospyros samoensis</i>			3	Fruiting during surveys
Maota	<i>Dysoxylum maota</i>			7	Fruiting trees during the survey. Good food source for pigeons and doves.
Magau	<i>Garuga floribunda</i>			2	
Pu'a vai	<i>Hernandia grandis</i>			4	
Futu	<i>Barringtonia asiatica</i>			10	fruiting
Niu	<i>Cocos nucifera</i>			1	
Matalafi	<i>Psychotria insularum</i>			5	Fruiting scrub, red berries
Leva	<i>Cerbera manghas</i>			2	
Atone	<i>Myristica inutilis</i>	076/200	54	10	
Futu	<i>Barringtonia asiatica</i>			10	

Fuafua	<i>Kleinhovia hospita</i>			5	
Magau	<i>Garuga floribunda</i>			5	
Maota	<i>Dysoxylum samoense</i>			3	
Lopa	<i>Adenanthera pavonina</i>	077/400	71	10	Suspect an invasive tree under the Samoa Invasive Species index
Fuafua	<i>Kleinhovia hospita</i>			2	
Auauli	<i>Diospyros samoensis</i>			5	
Talie	<i>Terminalia catappa</i>			3	
Pani	<i>Manilkara manilkara</i>	078/600	61	2	
Filimoto	<i>Flacourtia rukam</i>			2	
Laupapata	<i>Marcaranga harveyana</i>			15	Dominant species
Fasa	<i>Pandanus tectorius</i>			1	
Alaa	<i>Planchonella garberi</i>			2	
Lautivao	<i>Cordyline samoensis</i>			3	
Futu	<i>Barringtonia asiatica</i>			2	
Matalafi	<i>Psychotria insularum</i>			2	Fruiting shrub, red berries
Lopa				2	

Fetau	<i>Calophyllum inophyllum</i>	079/800	63	4	
Fao	<i>Neiosperma oppositifolium</i>			10	
Ifi	<i>Inocarpus fagifer</i>			11	
Nonu	<i>Morinda citrifolia</i>			5	
Tavai	<i>Rhus taitensis</i>			10	
Asi vai	<i>Syzygium clusifolium</i>			1	
Tagitagi	<i>Polyscias sp</i>			4	
Fau	<i>Hibiscus tiliaceus</i>			3	Flowering trees in the forest
Olamea	<i>Aidia cochinchinensis</i>			2	
Anume	<i>Diospyros samoensis</i>			1	
Fanaio	<i>Sterculia fanaiho</i>			1	Fruitibg trees in Nuutele forest

Tavai	<i>Rhus taitensis</i>	080/1000		2	
Atone	<i>Myristica inutilis</i>			2	
'Au'auli	<i>Diospyros samoensis</i>			3	
Maota	<i>Dysoxylum maota</i>			1	
Tamanu	<i>Calophyllum neo-ebudicum</i>			1	
Pu'a vai	<i>Hernandia grandis</i>			4	
Futu	<i>Barringtonia</i>			5	

	<i>asiatica</i>				
Niu	<i>Cocos nucifera</i>			1	
Matalafi	<i>Psychotria insularum</i>			5	
Magau	<i>Garuga floribunda</i>			1	
Ifi	<i>Inocarpus fagifer</i>			2	
Fau	<i>Kleinhovia hospita</i>			5	dominant tree
		081/1200	29		
Lama				3	
Futu	<i>Barringtonia asiatica</i>			1	
Fuafua	<i>Kleinhovia hospita</i>			5	
Ifi	<i>Inocarpus fagifer</i>			5	
maota	<i>Dysoxylum samoense</i>			3	
Atone	<i>Myristica fatua</i>			2	
		082/1400	24		
Fuafua	<i>Kleinhovia hospita</i>			2	
Auauli	<i>Diospyros elliptica</i>			5	
Talie	<i>Terminalia catappa</i>			3	
		083/1600	-14		
Niu	<i>Cocos nucifera</i>			2	Nuutele flat area, dominant tree

Pua vai	<i>Pisonia grandis</i>			5	
Auauli	<i>Diospyros elliptica</i>			15	Dominant tree in the plot
Fasa	<i>Pandanus tectorius</i>			1	
Fau	<i>Hibiscus tiliaceus</i>			2	
		084/1800	-34		
Milo	<i>Hernandia grandis</i>			2	
Matalafi	<i>Psychotria insularum</i>			2	
Lopa				2	
Masame	<i>Diospyros samoensis</i>			3	
Fetau	<i>Calophyllum inophyllum</i>			2	
Futu	<i>Barringtonia asiatica</i>			4	
Ifi	<i>Inocarpus fagifer</i>			1	
		085/2000	-34		
'Auauli	<i>Disopyros eliptica</i>			2	
Tavai	<i>Rhus taitensis</i>			1	
Asi vai	<i>Pisonia grandis</i>			1	
Tagitagi	<i>Polyscias sp</i>			2	
		086/2200	-29		
Pani	<i>Manilkara manilkara</i>			2	Very hard and good wood for axe

					handles.
Magau	<i>Garuga floribunda</i>			1	
Fagaio	<i>Sterculia fanaiho</i>			2	
Tavai	<i>Rhus taitensis</i>			1	
Atone	<i>Myristica fatua</i>			2	
'Au'auli	<i>Diospyros</i>			3	
Maota	<i>Dysoxylum samoense</i>			1	
Tamanu	<i>Calophyllum neo-ebudicum</i>			1	
Milo	<i>Hernandia nymphaeifolia</i>			1	
		087/2400	-43		
Matalafi	<i>Pyschotria insularum</i>			5	Common tree schrub in the plot
Gasu	<i>Palaquium stehlinii</i>			1	
Ifi	<i>Inocapus fagifer</i>			2	
Fau	<i>Hibiscus tiliaceus</i>			5	Common tree in this plot
Auauli	<i>Diospyros elliptica</i>			4	
Masame	<i>Diospyros samoensis</i>			2	
		088/2600	-24		
Pani	<i>Manilkara manilkara</i>			2	
Auauli	<i>Diospyros elliptica</i>			3	

Fau	<i>Hibiscus tiliaceus</i>			2	
Toi	<i>Alphitonia zizyphoides</i>			1	