BIOSECURITY AWARENESS RAISING AND INVASIVE SPECIES SURVEYS AT TABUAERAN AND TERAINA, KIRIBATI, MAY 2019

Feral dog in an estuarine saltmarsh near Napari, Tabuaeran.

Ray Pierce[1], Tiaeki Tanako[2], Katareti Taabu[3], Nicholas Ioane[2], Koma Teatoa[2]

1. Eco Oceania Pty Ltd, 165 Stoney Creek Rd, Speewah, 4881, Australia raypierce@bigpond.com
2. Agriculture Department, MELAD, Kiritimati, Kiribati C/- Tiaeki…
3. Environment Conservation Division, MELAD, Kiritimati, Kiribati

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ACRONYMS

AA	Agriculture Assistant of MELAD
ALD	Agriculture and Livestock Division of MELAD
CXI	Kiritimati, Christmas Island
ECD	Environment and Conservation Division
EDRR	Early Detection and Rapid Response
EN	Endangered under IUCN threat classifications
IAS/IS	Invasive alien species or invasive species
KDP	Kiribati Development Plan
KPA	Kiribati Ports Authority
LFA	Little Fire Ant
MELAD	Ministry of Environment, Lands and Agricultural Development
MFAT	New Zealand Ministry of Foreign Affairs and Trade
PB	Pacific Biosecurity
PIAT	Pacific Invasive Ants Toolkit
PIPA	Phoenix Islands Protected Area
RIFA	Red Imported Fire Ant
SPC	Secretariat for the Pacific Community
SPREP	Secretariat for the Regional Environment Programme
WCU	Wildlife Conservation Unit of ECD
YCA	Yellow crazy ant

SUMMARY

Biosecurity awareness raising and invasive species surveys were undertaken at Teraina and Tabuaeran, Kiribati, during 19-21 May 2019. Meetings were held with stakeholders who were directly or indirectly involved in island biosecurity work, and awareness material provided for schools, Island Councils, boarding parties, Agriculture Assistants and others. Surveys with Agriculture and Environment staff and others revealed the presence of Yellow Crazy Ants on Tabuaeran and several weed species on both islands. Crop species and indigenous plants generally appeared healthy. The recent arrival of Black Rats on Teraina means that contingency plans are needed for both the island's two threatened bird species, Te Bokikokiko and Te Kura.

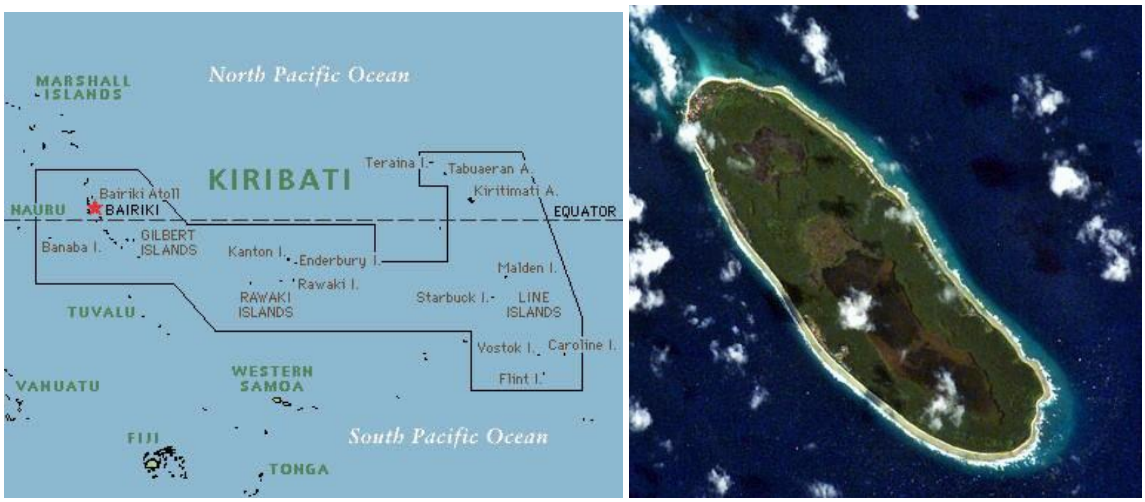

Fig 1 - Location of Tabuaeran and Teraina (top left) and Google map of Teraina (right)

Fig 1.1 – Google map of Tabuaeran

1. BACKGROUND AND OBJECTIVES

Tabuaeran (Fanning Island) and Teraina (Washington Island) are part of the Kiribati Line Islands and are located at 3.9 degrees and 4.7 degrees north latitude respectively. Tabuaeran (34 km^2) is a typical low-lying atoll with large lagoon and three main motu separated by channels, with many inlets forming saltmarsh-like conditions. Teraina (10 km^2) is a raised coral-limestone atoll with extensive freshwater wetlands, including Washington Lake ad associated swamps and reed-beds. Rainfall of both islands is high and seasonal with Tabuaeran averaging 2500 mm per annum and Teraina 3000 mm per annum (Watkins and Batoromaio 2014). Each island supports populations of about 2000 people and the habitats are dominated by coconut plantations that were expanded during the nineteenth and twentieth centuries. Both islands have long been serviced by regular cargo/passenger shipping services from Kiritimati and Oahu, Hawaii, and in 2016 this was extended to include twice weekly twin otter aircraft flights to and from Cassidy Airport, Kiritimati.

Native vegetation has been greatly diminished by the planting of coconut plantations, many of them centuries old (Wester et al 1992), but there are remnant stands of Te Buka, Te Ren and other forest trees and extensive estuarine (Tabuaeran) and freshwater (Teraina) habitats. Several threatened species occur in these habitats including coconut crabs (for scientific names refer to Appendix 2) and green turtles on both islands, while an endemic subspecies of Te Bokikokiko (*Acrocephalus aequinoctialis pistor*) occurs on Teraina, and the introduced Rimatara Lorikeet (EN) also occurs on Teraina. Te Bokikokiko and Te Buka formerly also occurred on Tabuaeran, but have apparently died out there for unknown reasons, the former before 1967. Little is known of the status of these two bird species and other indigenous biota and there have been growing concerns for the security of the Rimatara Lorikeet and Bokikokiko (VanderWerf and Pierce in prep).

The invasive species present on Teraina were surveyed by WCU in 13-17 September 2012 (WCU 2012), but no similar survey had been undertaken at Tabuaeran. A key focus of the current visits was to raise awareness on invasive species and undertake surveys for invasive ants, given the spread of several damaging species in and around the Pacific in recent years, including Little Fire ants and Yellow Crazy Ants. The latter species was also discovered on Kiritimati in March 2013, but the source and pathway of their invasion js unknown. As well as the invasive species awareness raising, there was a need to update knowledge on invasive mammals and plants on the islands as part of Pacific Biosecurity's sustainability programmes.

Key objectives for both islands were to:

1. Raise awareness of IAS issues and prevention measures among Council, boarding parties, importers and the general community,
2. Refresher training with ALD staff as needed, including reviewing risks assessments and emergency responses,
3. Survey for presence of Yellow Crazy Ant, Little Fire Ant and other invasive ants in seaports/landing areas, airports, warehouses and lodges.
4. Confirm rodent species in villages and in countryside and presence/absence of other feral mammals – cats, dogs, pigs.
5. Survey for invasive plants and crop pests.
6. Note indigenous fauna present.

Fig 1.2 – Wetlands of Teraina (left) including Washington Lake (right)

2. METHODS

Awareness raising, surveys and training were undertaken by the authors above who comprised ALD, WCU/ECD and Pacific Biosecurity representatives, and cross-training also occurred within this group. Key survey methods follow existing guidelines (Kiritimati Biosecurity, Pacific Invasive Ant Toolkit, Pierce et al 2018), and comprised the following:

1. Awareness raising – meetings with Island Council staff, and representatives of importers, education awareness, Kiribati Police, tourism, and all other opportunities as they arose. This included a biosecurity power point and PIAT overview in one meeting, plus posters for education awareness representatives and ALDs to subsequently present at schools, etc.
2. Risk assessments and precautions – given recent changes in IAS presence locally and establishment of air travel to the islands, we considered it prudent to review pathways and risks brought about by increased traffic, and corresponding biosecurity actions.
3. Invasive ant surveys – as part of surveillance training, we checked all Te Noni bushes in port/arrival areas and at other at-risk sites, e.g. landing areas, copra sheds, lodges, cargo depots, etc. This was supplemented with lures (protein and sugar lures) in the most at-risk areas. Suspicious ants were collected and photographed.
4. Rodents – we operated 12 WCU rat traps overnight mainly at Agriculture nurseries on the edge of the main village at each island. These were baited with coconut and a sample of 10+ rats sought per island to identify species.
5. Feral mammals – we kept track of feral dogs and cats sighted and noted comments from residents on numbers, impacts and distribution.
6. Invasive plants – we targeted the most likely invasives (Lantana, sweet-scent, etc) and any additional species listed as undesirable for Kiribati in Space and Imada (2004).
7. Crop pests - ALD staff surveyed and documented suspected diseases and pest incursions.
8. Fauna – we documented key biota, particularly threatened species – Te Bokikokiko, Te On (Green Turtle), Te Kura (Rimatara Lorikeet). Te Bokikokiko was the subject of a separate targeted survey at Teraina (Pierce and Taabu 2019).
9. ALD training – inclusive in all steps above.

Timetable May 2019

Date	Location	Main activity
6-8	CNS-CXI	RP travel
9	CXI-TAB	RP KT TT
10	Tabuaeran	Meet mayor am; pm ant and weed surveys, rat trapping
11	Tabuaeran	Village surveys (weeds, ants, rats) general consultation
12	Tabuaeran	North Tabuaeran surveys with IAS team and Minister MLPID
13	Tabuaeran	Biosecurity meeting with stakeholders am; further ant surveys; debriefs
14	TAB-TER	Flight to Teraina pm
15	Teraina	Meet with Mayor and stakeholders am; pm survey landing and wetlands
16	Teraina	Ant and weed surveys N side island; pm rat trapping
17	Teraina	BOK surveys am; lantana ERR assessment pm
18	Teraina	BOK surveys am; dog and rat surveys pm
19	Teraina	Rain am; BOK surveys all day (RP)
20	Teraina	BOK surveys am; debrief meeting with Mayor pm
21	Teraina-CXI	BOK surveys am (RP); IAS team flew to CXI pm
22	CXI-NADI	YCA survey am; debrief Minister; RP depart for Fiji pm
23	NADI-CNS	RP travel

A complementary project partially funded by TNC focused on the Bokikokiko on Teraina on the mornings of 17-21 May (Pierce and Taabu in prep.).

3. TABUAREAN RESULTS

3.1 General biosecurity awareness raising

Meetings were held with the Mayor and Acting Clerk on 9 May and with stakeholders on 10 May, the latter comprising senior representatives from Customs, Police, Health, Education, Kwai agent and Cruise-liner agent, together with our team from Agriculture (TT and TA), Environment (KT) and RP. We presented power points covering an overview of biosecurity risks and pathways tailored for Tabuaeran with examples of approaches to prevent invasions, plus discussion of identifying and understanding invasive ants, using as prompts the laminated posters and the PIAT toolkit. The group then discussed key concerns and needs at Tabuaeran, including the following:

- developing a better awareness of IAS threats that could potentially arrive (see Appendix 1)
- dealing with existing IAS including wild dogs and rats
- understanding and managing threats to coconut production and other crops
- dealing with increased rashes on children possibly brought about through invasive ants (raised by Health nurse).

The Minister of MLPID hosted an evening on 13 May where RP also spoke of risks of invasive ants and the need to better understand where YCA were distributed on the island, and opportunities and constraints for dog and rat management. Specific invasive issues are discussed below.

Fig 3.1– Awareness meeting with Tabuaeran stakeholders.

3.2 Invasive ants

Surveys for YCA and other invasive ants revealed the presence of YCA on Tabuaeran, where we found them at two widely separated sites (Fig 3.2, Table 3.1). One site was on the edge of a coconut forest of East Tabuaeran and the other was in gardens between Paelau and Teurithiki Villages.7

Table 3.1 – Details of invasive ant surveys undertaken on Tabuaeran and results: Note: N40 refers to 40 Te Noni being checked, L5 = 5 paired lures set, etc, V = walk-through visual.

Date	Time	Location	GPS Lat/long 3.xxx 159.xx	Area/ Length	Habitat	Method	IAS found
9	1610-1700	Paelau	8559; 3595	1.3.km	Dwellings	N40	0
10	1100-1200	Paelau	8560; 3594	1 ha	Dwellings	N6	0
10	1110-1200	Bruno's Lodge	8531; 3619	0.5 ha	Dwellings	L5 N6	0
10	1120-1220	English Lodge	8544; 3630	0.5 ha	Dwellings	L5	0
10	1120-1220	Kwai Agent	8541; 3606	0.5 ha	Garden	L4	0
10	1125-1225	Agriculture	8542; 3603	0.5 ha	Garden	L4	Pharaoh A
12	1510-1710	E Tabuaeran	8710; 2743	2.3 km	Plantation	V	**YCA**
13	Pm	West Landing	8604; .3637	0.5 ha	Landing	L5	0
13	Pm	Airport, village	8600; 3635	c.1 ha	Mosaic	L5	0
13	1425-1525	Paelau Copra	8703; 2742	0.5 ha	Shed	L5	0
13	1430-1530	Paelau Copra2	8752; 3594	0.5 ha	Building	L4	0
13	1550-1620	Teurithiki West	8532; 3578	0.5 ha	Village	N5	**YCA**
13	1620-1730	Teurithiki East	From above to 8530; 3580	1.5 km	Village	N40	0

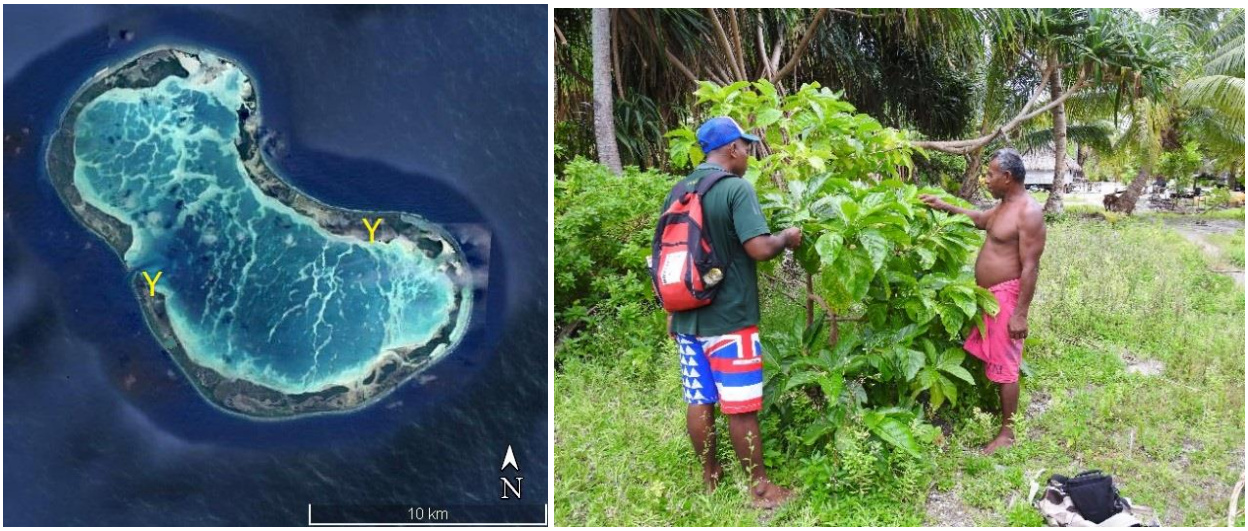

Fig 3.2 – Tabuaeran surveys detected YCA at two widely separted locations marked Y (L) and including these village Te Noni (right).

Fig 3.3 – YCA on Noni flowers at Teurithiki Village.

3.3 Wild (feral) dogs

Wild or feral dogs were reportedly widespread on Tabuaeran. Permanently feral animals are reported from some areas, e.g. East Tabuaeran, and semi-feral to feral animals around villages, e.g. some dogs were sighted in a saltmarsh wetland near Napari on 13th May (NI, RP). Tabuaeran has limited freshwater and the East Tabuaeran animals reportedly use a permanent water hole near the eastern YCA site depicted in Fig 3.2.

Fig 3.4 – a collared dog indicating registration and two uncollared (i.e. “feral”) dogs at Paelau.

3.4 Rats (Kimoa)

Victor rat traps were operated for 3 nights at each of Bruno’s Lodge and nearby Agriculture Nursery. Ten rats were caught comprising 8 Black Rats and two Pacific Rats (Fig 3.5, Appendix 2).

Fig 3.5 – *Rattus rattus* (upper specimen) and *R exulans* captured at Paelau, May 2019.

3.5 Weeds

Many exotic species have been deliberately planted over the years and others probably accidentally introduced. Notable species were:

- Many old growth trees, some possibly historic trees, including Phoenix palm and Acacia.

- *Leucaena* – well established and spreading out from the villages
- Sweet-scent – well established and spreading out from the villages
- Lantana – well established at Paelau Village and spreading pout from there
- Many grasses in Paelau and other villages.

Fig 3.6 - Old wattle (*Acacia* sp.) left and a stand of *Leucaena* at Paelau (right).

3.6 Tree health

Unhealthy coconuts were found by NI and TT in one area of Tabuaeran (Eden and Paelau Village). This is believed to be caused by a known pest ("coconut leaf caterpillar", probably Coconut Flat Moth - *Agonoxena argaula*) which can be serious if the pest is in high population densities. These pests feed on the green underside of the mature coconut leaf where they make galleries on the underside of the leaflet using silk and faecal material (Fig 3.6, 3.7).

Fig 3.6 – Coconut leaf caterpillar and damage to coconuts.

Elsewhere coconuts were often poorly managed resulting in low light levels reaching the understory and even the growing parts of many coconuts (Fig 3.7).

Fig 3.7 – Damaged coconut from coconut leaf caterpillar (left) and dense coconuts preventing ground plants from establishing (right).

4. TERAINA RESULTS

4.1 General biosecurity awareness raising

Our team held a meeting with Council reps (Mayor Kannefou and Acting Clerk Ioanna) and other stakeholders including Island Education Coordinator (Louisa) and Kwai agent (Johnny) at 0815-1000 on 15 May. Key discussions focused on biosecurity (including being aware of YCA on Tabuaeran) and potential eradications on Teraina, especially of feral dogs. Additional consultations were held with opportunistically with village representatives, lodge owners and the Acting Fisheries Officer. Follow-up meetings were held with the mayor and the Acting Clerk almost daily to update them on progress with surveys for ants, rats, weeds, etc. and to particularly discuss the potential to eradicate Lantana. The interisland cargo and copra vessel LC Linnix arrived at the landing on 20 May and this important community event was used to emphasize the need for strengthening biosecurity, and discussions at the landing were held with observers, rice distributors, etc.

Fig 4.1 – Awareness raising games (left) and posters (right).

4.2 Invasive ant surveys

Invasive ant surveys were undertaken as per Tabuaeran, i.e. checking Noni trees (N) throughout and luring (L) with peanut butter and jam at perceived risk points (landings, copra sheds). No YCA were found and the only invasive ants detected were Big-headed Ant (Table 4.1).

Table 4.1 – Details of invasive ant surveys undertaken on Teraina. L, N, V as for Table 3.1.

Date	Time	Location	GPS Lat/long 4.xxx; 160.xxx	Area/ length	Habitat	Method	IAS found
15	1050-1150	Landing	6832; 4028	100 m	Mosaic	L 10	BHA
15	1100-1130	Landing-Village	to 6878; 4085	800 m	Gardens	N62	BHA
16	0930-1025	Village – Airport	to 6978; 3960	c.1 km	Mosaic	N61	0
16	0950-1035	Airport area	6978; 3960	c. 2 km	Mosaic	N12	0
18	1520-1620	Village	6883; 4086	0.5 ha	Copra shed	L5, N3	0
18	1530	Kwai depot	6859; 4063	0.5 ha	Building	N 6	0
19	1420	SE Village	6705; 3789	c.1km	Gardens, buildings	N35	0

Key: BHA = Big-headed Ant

Fig 4.2 – A Noni-checking team (left) and unloading the landing craft (right)

4.3 Wild (feral) dogs

As with Tabuaeran, Terraina has a significant wild/feral dog issue. During the day on 18 May we heard a pack of wild dogs in the Te Buka-Fig area north of the Agriculture Nursery. On 20 May a pack was seen to visit the Agriculture Nursery and it comprised two male dogs, 5 females and at least two pups (TT pers. obs.). These dogs are said to eat birds, chickens, rats, etc. They are reported to chase people, and parents tend not to allow their children enter these risky areas, although we heard no recent reports of dogs biting people, but WCU noted this in 2012. Unlike Tabuaeran, there is no fresh water shortage on Teraina. It is not clear how many wild dogs there are on the island. Part of the problem is that there is a range of "wildness" behaviour present, ranging from permanently wild dogs to those that join the packs opportunistically, often at night. For example, two of the three dogs at our lodge were there permanently, but the third was said to join the nocturnal pack(s), but it was still regarded as a "lodge dog". Other problems for that would face

dog management include children being “everywhere” on both islands especially weekends and holidays, and few open sites for shooting like this strangler fig area (Fig 4.4) on Teraina.

Fig 4.3 – During the school holidays and probably weekends during school term children roamed well away from villages (these on Tabuaeran).

Fig 4.4 – One of few open areas on Teraina amongst Te Buka and figs near the Agriculture nursery which showed potential as a dog-luring site.

4.4 Rats (Kimoa)

Up to 12 rat traps were operated at the Agriculture Nursery for 5 nights during which 6 Black Rats were caught (Appendix 2). The traps were retained by the AA after our visit for further trapping to test whether other rats, e.g. Pacific Rat, are also present, as per Tabuaeran.

4.5 Lantana and other weeds

Several small patches of Lantana were seen in the main village and another a few hundred metres east of the Landing. The main village's patches of Lantana were aggressively colonising the grassland and gardens of the area and are clearly going to present a serious management problem for the island in the future. We discussed options for the management of these weeds with the Mayor who indicated that he would raise the issue for discussion at the next Council meeting, but in the mean while we provide some further general guidance as per the table below.

Table 4.2: Some options and preferred management of Lantana at Teraina.

Option	Outcome	Actions
1. Do nothing (Undesirable)	Smothering of gardens, fruit trees and native ecosystems	None
2. Contain to present area (Ineffective)	Dense infestation in contained area, many new infestations farther away as a result of seed dispersal by lizards and Te Kura, ongoing management	A) Fence existing sites B) Survey and map new sites C) Weed these new sites 2 x annually by cutting off fruit before ripens (bag and burn) and dig out rest of plants by roots (burn)
3. Eradicate (Desirable)	Gardens, fruit trees, ecosystems recover	A. Survey and map all sites B. Collect fruit before it ripens, bag, and burn; C. Remove all plants by digging out by roots, burn D. Repeat above process 2x annually

Some other weeds of concern were:

- *Leucaena* – widespread in villages but not yet abundant
- Sweet-scent – widespread in villages but not yet abundant

We recommend that the above weeds also be assessed for the potential to eradicate. It was notable that *Wedelia* (Singapore Daisy), which would aggressively colonise this high rainfall environment, has not reached these islands to date and the importance of excluding this highly invasive weed was emphasized to the Mayor.

4.6 Tree health

No unhealthy crop trees were observed, but one group of Te Ren east of the airfield showed signs of dieback from unknown causes.

Fig 4.5 – Dead and unhealthy Te Ren trees Teraina.

4.7 Other environmental issues

Some other important environmental issues were noted on Teraina including:

- Te Kura and Te Bokikokiko are Endangered and susceptible to Black Rats (which have invaded Teraina) with Te Bokikokiko also being susceptible to development and weed invasion and associated habitat loss. The situation and recommendations for Bokikokiko are provided in a separate report (Pierce and Taabu 2019), but the issue with Te Kura appears to be more acute and urgent to address as it is extremely sensitive to *Rattus rattus*, dying out where these rats invade (refer Section 4.8 for recommended management options).
- Te Kura take coconut sap designed for coconut toddy (Fig 4.6) and are regarded as a nuisance because of this. One option for management if this is a serious problem is to place netting over the collection device, which would be far more preferable to killing this Endangered species.
- Dense coconut plantations throughout much of the island have resulted in the loss of important stands of Te Buka and other forest trees which are crucial for Te Bokikokiko survival. These threatened birds are now largely confined to a narrow band of Te Ren/Te Buka associations around the island perimeter - refer to the study of Pierce and Taabu 2019 (draft) for details and solutions offered.

- Illegal hunting of Te On and Te Ngutu was observed, and Te Koota were reportedly also being taken. As at Kiritimati, if locally reared/farmed chickens were more widely available it would reduce the desire or need to kill these protected species.
- Some comments were heard on Teraina regarding possible development plans for the wetlands and elsewhere. MELAD needs to be involved with careful assessment of the environmental effects, impacts on tourism, etc. of any such proposals.
- Lake Washington's ecology has reportedly been compromised from the introduction of *Tilapia* sp. Further plans here should involve a carefully prepared assessment of environmental effects.

Fig 4.6 - Te Kura feeding on sap of recently cut coconut intended for toddy production.

5 RECOMMENDATIONS

YCA on Tabuaeran

- On Tabuaeran undertake surveys for additional sites of YCA including copra shed east of island, KOIL compound, and additional villages as opportunities arise. The AA (NI) has this in hand.

- On Tabuaeran talk with school children and communities around the posters, emphasizing the need to identify where YCA are distributed on the island and determine if they are colonising new areas (AA)
- If people are troubled by YCA, encourage use of boiling water to kill queens in the nests – this may need persistence and some experimentation, e.g. how deep are the nests in sand etc? Be aware that some queen ants are winged and can fly off when disturbed.

Biosecurity awareness

- AA and community at **Teraina and Kiritimati** need to be aware of risks of importing materials from Tabuaeran that could contain YCA – copra, pandanus, timber, drums, supplies, etc. The AA and Agriculture are aware of this need and will discuss further with community, school talks, etc.
- AA and community at **Tabuaeran** need to be aware of potential threats of vessels and aircraft arriving from different sources as per the risk assessment in Appendix 1, e.g. give special attention to any vessels arriving directly from Hawaii and Tahiti. As a border port Tabuaeran is essentially in the same vulnerable position as Kiritimati.
- Biosecurity needs strengthening generally on **Tabuaeran and Teraina,** taking account of risks, pathways and actions of Appendix 1.

Existing invasives

- Dogs on both islands need to be better controlled through a system of registration and collaring (being implemented on Tabuaeran) and potentially the culling of feral dogs. Agriculture, through the AA and visits by Kiritimati staff, are in a good position to collect further background information on dogs and community perceptions towards them.
- Feral pigs – suggestions of the presence of feral pigs need confirmation (AA both islands) which if present, would impact on coconut crab populations, etc.
- Rats on Teraina – it is unknown whether *Rattus exulans* are also present – AA Teraina will continue trapping to answer this question (refer Bokikokiko survey report).

Endangered Birds on Teraina

- Given that *Rattus rattus* has invaded Teraina, there is a need to manage and monitor both the Te Bokikokiko and Te Kura.
- Te Bokikokiko is the subject of a separate report (Pierce and Taabu 2019).
- For Te Kura an action plan should be prepared addressing potential management options e.g. tree-ringing (which prevents rat access to both nests and has the added benefit of reducing rat damage to coconuts), rat eradication potential, translocation potential, etc. and monitoring.

Equipment

The AA on both islands have little technical equipment and some items identified as being needed include brushes, mixed vials, labels and preservative (for ant ID), camera, GPS and laminated island map for general purpose biosecurity.

ACKNOWLEDGMENTS

We thank Pacific Biosecurity and VicLink for funding this awareness and survey work as part of Pacific Biosecurity's sustainability programmes; staff of MELAD for facilitating their participation along with the island AAs; island mayors, council staff and lodge owners and staff for their logistic support on the islands.

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Appendix 1 – Invasive Species Threats Pathways to Tabuaeran and Teraina

A. Tabuaeran (adapted from K-NISSAP.)

Pathway	Source	Invasive species threats	Risk level
CXI supply vessels	CXI – several annually	Rodents (Pacific rat, black/ship rat, mice) Invertebrates Weeds	High High High
Kwai	Honolulu, Cooks, Line Is – several visits annually	All of above (rodents, ants, weeds like *Wedelia*) plus cane toad, mongoose, giant African snail, reptiles, other ants e.g. YCA, RIFA, avian malaria.	High
Yachts and voyaging canoes	Fr Polynesia, USA – several annually	Little fire ant, yellow crazy ant, red imported fire ant Other invertebrates (e.g. fruit fly) Rats and mice Pets (e.g. dogs, cats, birds, etc.)	High High High Moderate
Cruise liners	Honolulu, Tahiti – a few each year	As for yachts and canoes above	High
Wrecks	Anywhere – rare	Rats, mice and invertebrates	Extreme
Aircraft, passenger and freight	CXI – twice weekly and charters	Rodents (rats and mice), ants, other invertebrates, weeds	High

B. Teraina

Pathway	Source	Invasive species threats	Risk level
CXI supply vessels	CXI, Tabuaeran	Rodents (Pacific rat, black/ship rat, mice) YCA (Tabuaeran) Invertebrates Weeds	High High High High
Kwai	Honolulu, Cooks, Line Is	All of above (rodents, ants, weeds like *Wedelia*) plus cane toad, mongoose, giant African snail, reptiles, other ants e.g. YCA, RIFA, avian malaria.	High
Yachts and voyaging canoes	Fr Polynesia, USA Lines	In theory low risk as these vessels should have visited international port (CXI or Tabuaeran), but always expect the unexpected	High
Wrecks	Anywhere	Rats, mice and invertebrates	Extreme
Aircraft, passenger and freight	CXI	Rodents (rats and mice), ants, other invertebrates, weeds	High

Appendix 2 – Rat morphometrics at Tabuaeran and Teraina

Figures denote mean measurements (with the range given in parentheses)

Island	Tabuaeran (n = 10)		Teraina (n = 6)
Species	Black Rat (8)	Pacific Rat (2)	Black Rat (6)
Morph	White-bellied 8	Dark brown	White-bellied (4), Intermediate (1), Black (1)
Sex	2M 6F	1M 1F	3M 1F 2U
HBL	163 mm (126-187)	137.5 mm (128-147)	153 mm (84-184)
Tail length	175 mm (152-191)	134 mm (127-141)	185.5 mm (128-205)
Weight	153 (84-184)	49.5 g (46-53)	108.7 g (36-184)
Ear/Eye	Yes x 8	No x 2	Yes x 6
Foot scar	No x 8	Yes x 2	No x 4, U x 2

Appendix 3 – Names of species mentioned in the text

Big-headed Ant – *Pheidole megacephala*
Black Rat/Ship Rat - *Rattus rattus*
Cane Toad - *Bufo marinus*
Coconut Rhinoceros Beetle - *Oryctes rhinoceros*
Coconut Crab - *Birgus latra*
Feral Dog - *Canis familiaris*
Feral House Cat - *Felis catus*
Lantana *Lantana cantareus*
Leucaena - *Leucaena leucocephala*
Little Fire Ant - *Wasmannia auropunctata*
Mongoose (Grey Mongoose) - *Herpestes auropunctatus*
Mosquitoes e.g. *Aedes aegypti*
Norway Rat - *Rattus norvegicus*
Red-imported Fire Ant - *Solenopsis invicta*
Singapore Daisy - *Wedelia trilobata*
Snakes e.g. Brown Tree Snake - *Boiga irregularis*
Sweet-scent - *Pluchea odorata*
Te Ango - *Premna serratifolia*
Te Bokikokiko, Christmas Island reed-warbler - *Acrocephalus aequinoctialis pistor*
Te Buka - *Pisonia grandis*
Te Itai - *Calophyllum inophyllum*
Te Kaina - *Pandanus tectorius*
Te Kanawa - *Cordia subcordata*
Te Kaura - *Sida fallax*
Te Kewe or Bristle-thighed Curlew - *Numenius tahitiensis*
Te Kimoa or Pacific Rat sometimes includes Black Rat - *Rattus exulans/R rattus*
Te Kinongo or Yellow Crazy Ant - *Anaplolepis gracilipes*
Te Kirikiri or Wandering Tattler - *Tringa incanus*
Te Kitibwa or Ruddy Turnstone - *Arenaria interpres*
Te Kun or Pacific Golden Plover - *Pluvialis fulva*
Te Kura or Rimatara Lorikeet - *Vini kuhlii*
Te Mao - *Scaevola taccada*
Te Maukinikin or Puncture Vine - *Tribulus cistoides*
Te Ntenenei - *Cassytha filiformis*
Te Ni - *Cocos nucifera*
Te Noni - *Morinda citrifolia*
Te On or Green Turtle - *Chelonia mydas*
Te Raurau or Blue Noddy - *Procelsterna cerulea*
Te Ren or Heliotrope - *Tournefortia argentea*
Te Ruku - *Ipomoea littoralis*
Te Tuna or Eel - *Anguilla* sp.
Te Uri - *Guettarda speciosa*
Te Utuete - *Lepturus repens*
Tilapia - *Oreochromis* sp.
Yellow Crazy Ant – *Anoplolepis gracilipes*

Appendix 4 – Summary of birds observed at Tabuaeran and Teraina, May 2019

Species	Status
Te Tanguoua - Wedge-tailed Shearwater	Both islands - occasionally seen offshore
Te Taake - Red-tailed Tropicbird	Tabuaeran - one sighting
Te Ngutu - White-tailed Tropicbird	Both islands - nesting, very common on Teraina, 200+ pairs
Te Mouakena - Masked Booby	Both islands - a few seen offshore not ashore
Te Kibwi - Brown Booby	Both islands - up to 20 fishing at Washington Lake, Teraina
Te Koota - Red-footed Booby	Both islands - common and nesting
Te Eitei Are e Bubura - Great Frigatebird	Both islands - moderately common, no sign of nesting
Te Eitei Are e Aki Rangi Ni Bubura - Lesser Frigatebird	Rare both islands
Te Kun - Pacific Golden Plover	Tabuaeran - seen daily in flocks of up to 10
Te Kewe - Bristle-thighed Curlew	Tabuaeran - seen most days in flocks of up to 6
Te Kirikiri - Wandering Tattler	Both islands - heard most days
Te Kitibwa - Ruddy Turnstone	Tabuaeran - one flock of 6
Te Keeu - Sooty Tern	Both islands - few seen as singles, twos
Te Io - Brown Noddy	Both islands - common and nesting
Te Mangikiri - Black Noddy	Both islands - abundant and nesting
Te Raurau - Blue Noddy	Teraina - one seen flying near airport on 21 May
Te Matawa - White Tern	Both islands - common and nesting
Te Kura - Rimatara (Kuhl's) Lorikeet	Teraina - abundant and nesting; 1 ha x 1 min counts produced up to 10 birds in coconuts and over one thousand birds present on the island (data to be fully analysed), adults more commonly observed than immatures.
Bokikokiko - Christmas Island Warbler	Teraina - moderately common and nesting

Appendix 5 – YCA on Kiritimati May 2019

RP surveyed most of the Te Noni within the YCA treatment area at Kiritimati from 0615 to 0635 on 22 May 2019. About 15 YCA were found on one isolated Te Noni bush behind the Fisheries building at 01.98364; 157.47198. WCU staff then surveyed Te Noni in the entire area at 1000-1030 and found no YCA, verified by RP for the Te Noni bush at 1040 h. The temperatures were significantly lower (< 30 C) during the early morning survey, but by 1040 it was sunny and hot and YCA activity was clearly inhibited. WCU propose to carry out an early morning survey on 23 May and use bait to treat in and around the infestation area.