GUIDELINES FOR MONITORING BIRDS AND INVASIVE SPECIES AT KIRITIMATI, KIRIBATI

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Frontespiece - evening flight of Te Ruru over Big Nimroona December 2011

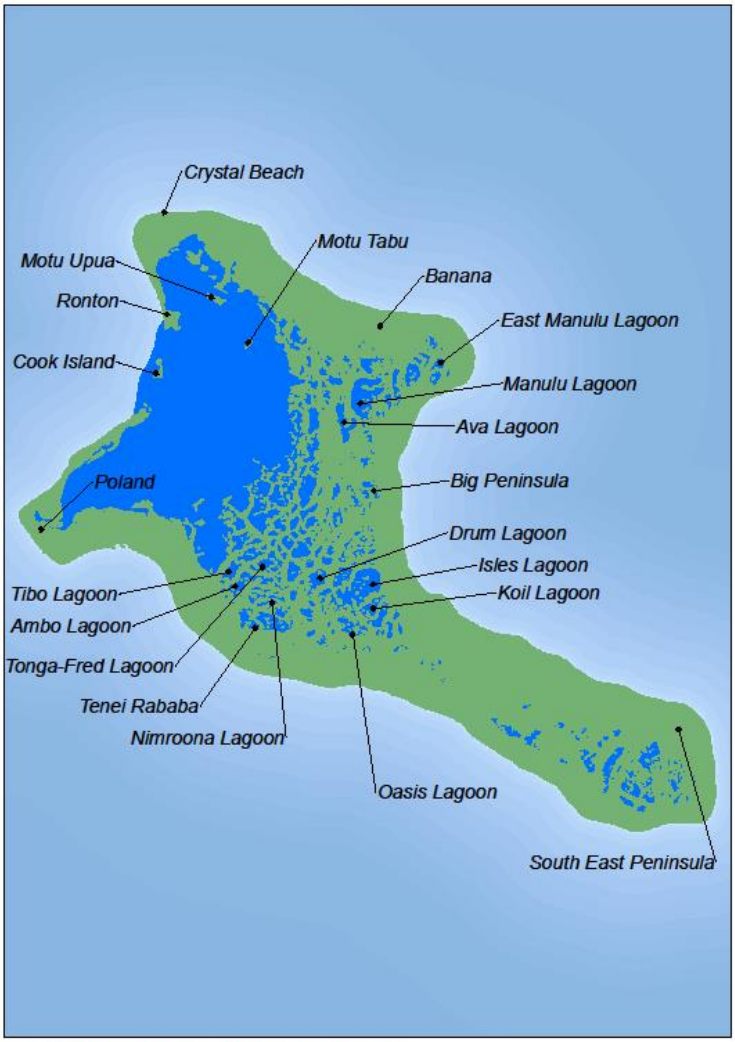


Fig 1.1 – Approximate locations of some key bird and monitoring sites at Kiritimati

EXECUIVE SUMMARY

These guidelines provide a framework for bird species monitoring and invasive species surveillance at Kiritimati. They are intended for use by the Wildlife Conservation Unit (WCU) at Kiritimati. The guidelines focus on simple field methods that can be easily applied to detect changes over time in populations and productivity of threatened species and other key species, of which Kiritimati has many. They are also designed to allow interpretation of the causes of trends in population and/or productivity. Although intended for use by the WCU at Kiritimati they are also applicable for monitoring and surveillance in the Phoenix Islands Protected Area (PIPA).

1 BACKGROUND AND OBJECTIVES

Kiritimati (CXI) supports globally important bird populations including a number of threatened species, notably the Phoenix Petrel (Te Ruru), White-throated Storm-petrel (Te Bwebwe Ni Marawa) and Christmas Island Warbler (Bokikokiko) (refer Appendix 1 for scientific names). Large populations of other seabirds are also present, including shearwaters (3 species), boobies (3 species), frigatebirds (2 species), tropicbirds (2 species, one of which is common) and terns (6 species) (refer Appendix 1). Virtually all of these seabirds are under threat from a combination of human-induced factors including the following:

- predation by invasive species, particularly the long-term impacts of Pacific rats (*Rattus exulans*) and feral house cats (*Felis catus*), but also through the more recent arrival of black rats (*Rattus rattus*) at Kiritimati
- poaching of seabirds by people for food
- impacts of pollutants and commercial fishing on seabirds and their food supplies
- potential impacts of weather events (e.g. El Niño oscillations) and human-induced climate change on food availability for seabirds and quality of their nesting areas.

It is the perception of some staff of Ministry of Environment, Lands and Agricultural Development (MELAD) and visitors that many of the bird populations have declined over the decades, but there are precious few data to quantify this, let alone determine cause(s) of declines. For example, 2010 estimates of Phoenix Petrels at CXI (c.10,000 pairs) were similar to estimates for this species 30 years previously, but there is no way of knowing if these apparent similarities are accurate because survey methods used in the past were generally not documented. What is a fact is that the Kiritimati populations of Phoenix Petrel (and storm-petrels and Bokikokiko) are critically important for the survival of their species and therefore we need a better understanding of health and population trends of these and other species into the future.

The objectives of this document are to provide:
1. simple monitoring guidelines for determining population trends of key species
2. an approach that helps to interpret causes of any population decline or increase
3. general monitoring guidelines for native and invasive species at priority sites where there are opportunities for rapid management responses such as eradicating invading rats or cats or targeting of poachers.

2 PRIORITY SPECIES AND SITES FOR MONITORING

In designing a bird monitoring programme for CXI, it is important to declare the priority species for protection and monitoring – clearly the endangered **Te Ruru** and **Te Bwebwe Ni Marawa** and endemic and vulnerable **Bokikokiko** are top priority species, but other species have important populations at CXI (see below). The CXI surveys undertaken by WCU and supporters since 2007 have helped to identify the highest priority sites for protection of specific birds and the risks facing them. This has enabled recognition of the highest priority sites for management, surveillance and implementing rapid response to any incursions of invasive species or poaching events that might occur. Table 2.1 below ranks these sites on a 1-3 scale.

Table 2.1 –Highest ranked sites for importance in protection of seabirds (updated from Pierce and Brown 2012 with 2016 and 2017 data). Orange = rank 1, green = rank 2.
Note 1: FC = feral cat; +/- K = Kimoa (*Rattus exulans*) periodically invade as is the case in 2017, but have been removed in the past, especially in 2009.

Motu/lagoon	Rank	IAS[1]	Importance at 2017
Motu Tabu	1	-	Equal largest global numbers of Te Ruru and Te Bwebwe
Big Drum	1	-	Equal largest numbers of Te Ruru, Te Bwebwe increasing
Cook Island	1	-	Important for many species, Te Ruru recolonizing
Big Nimroona	1	+/-K	Equal largest numbers of Te Ruru, kimoa sometimes invade
SW Nimroona	1	+/-K	4th largest numbers of Te Ruru, kimoa sometimes invade
Big Peninsula	1	K, FC	Largest Tanguoua colony on CXI
SE Peninsula	1	K, FC	Largest Te Keeu (Sooty Tern) colony on CXI
Manulu Lagoon	1	-	6+ motu used by Te Bwebwe; also E Manulu Lag, 1 motu
Poland Channel Motu	2	-	Two important motu for Te Ruru and Te Bwebwe
Carver 1-4 lagoon motu	2	-	5+ important motu for Te Bwebwe motu, also Te Ruru
Iareto Lagoon motu	2	-	Important motu for Te Bwebwe and Te Ruru
Isles Lagoon motu	2	+/-K	3+ important motu for Te Bwebwe
Big Tonga-Fred	2	-	Important for many species, Te Bwebwe recolonizing
Motu Upua	2	+K	Te Ruru declining, kimoa present, heavily poached
Ambo and Tibo motu	2	-	Several important motu for Te Bwebwe and Te Ruru
Frigatebird	2	+K	Lesser frigatebird colony – if de-ratted, likely Rank 1
Oasis motu x 3	2	-	Te Ruru et al recovering here (de-ratted), Te Bwebwe?
Ava Lagoon motu	2	-	3+ small motu important for Te Bwebwe

Formerly values on Motu Tabu surpassed those at all other CXI sites, but recolonization and increases of species populations on four other motu means that there are now five outstanding motu. Meanwhile two mainland sites (Big Peninsula and SE Peninsula) are added to Rank 1 sites as they represent the most important sites left at CXI for Tanguoua and Te Keeu. About 10 other motu (or clusters of motu) rank as 2 because they are also sites for smaller numbers of the endangered Te Ruru and Te Bwebwe Ni Marawa, and sometimes other species. Some of these Rank 2 motu have had kimoa removed since 2009.

The immediate threats to the bird populations are primarily predation by invasive species (pests)

and humans. Table 2.2 estimates the current types and levels of impact on different CXI species and is based on observations in Kiritimati in 2007-17 and the PIPA in 2006-13.

Table 2.2 –Severity of impacts of pest species and humans on seabirds at CXI. Note: "High" is unsustainable in long term, "Catastrophic" is unsustainable in short and long term.

Species	Kimoa/Pacific rat	Black rat	Cat	Human hunting
Te Ruru	Moderate to high	Catastrophic	Catastrophic	Locally catastrophic
Te Bwebwe	Catastrophic	Catastrophic	Catastrophic	Low
Shearwaters	High except perhaps Tanguoua	Catastrophic	Catastrophic	Locally high
Tropicbirds	Low	High	Catastrophic	High, locally catastrophic
Boobies, frigatebirds	Low	Moderate	Moderate to high, locally catastrophic	Locally catastrophic
Terns	High	High to catastrophic	High to catastrophic	Moderate
Te Raurau	Catastrophic	Catastrophic	Catastrophic	Low
Bokikokiko	Moderate?	Potentially catastrophic	Moderate?	Low

Summarizing Table 2.2, rats and cats are the greatest immediate threat to endangered species and small ground-nesting species (Phoenix Petrel, storm-petrel, Blue Noddy, possibly also Bokikokiko), especially when rats or cats gain access to formerly rat-free or cat-free motu. Black (ship) rats may pose a much greater threat than the kimoa in the long-term but they appear to be confined to coconuts and villages at present, but they should be monitored. People are the greatest threat to the large seabirds and can have a catastrophic impact locally, including on Phoenix petrels when other larger seabirds are depleted). There is also the potential for a few poaching events to deplete the breeding populations of lesser and greater frigatebirds to the point of total colony failure at CXI.

WCU are managing these impacts as follows:

- Surveillance for kimoa and cats on Rank 1 islands and planning for rapid response baiting to any incursions
- Surveillance for poaching on Rank 1 sites and generally through central lagoons area
- Seasonal cat control at Big Peninsula's Tanguoua colony February-November
- Seasonal cat control at Mouakena's (SE Peninsula) Sooty Tern colony as needed.

Taking the above scenarios into account, the native and invasive species that should be monitored are listed below in Table 2.3.

Table 2.3 – General priorities for monitoring and surveillance of birds and invasives. Orange = top priority (do each year). Detailed monitoring prescriptions for all species are provided in Section 3.

Species	Timing	Where and how?
Cats	Weekly to quarterly	Motu Tabu/Cook weekly; Drum/Nimroona 2 x annual; Big Pen 2 x annual
Kimoa and black rat	Weekly to quarterly	Motu Tabu weekly; Drum/Nimroona 2 x annual; also trapping surveillance for black rats near Priority 1 sites, e.g. Central Lagoons
Te Ruru	Annually, Nov-Dec	Fly-on counts as per section 3.1
Te Bwebwe	Any time	Map motu where Te Bwebwe are seen landing (See 3.2)
Te Tanguoua	May-June and Nov	Monitoring as per Section 3.5
Te Taake	May-June	Motu Tabu, Drum, Nimroona, Big Pen, birds poached
Te Etei area	Annually, Nov-Dec	Check colony is OK on Frigatebird; check for poaching
Te Keeu	At end of laying	GPS area of colony; also record any mass mortality
Bokikokiko	May-June	Transects, reduce frequency if stable population
Shearwaters	Any time	Nothing specific – presence/absence motu data sheets
Te Kibwi	Any time	Island data sheets
Te Koota	Any time	Island data sheets
Te Mouakena	?	Possibly photography via plane/drone
Te Etei Rangi	Any time	Map colonies, record poaching on motu sheets
Te Io	Any time	Island data sheets – presence/absence
Tarangongo	Any time	Island data sheets – record successful/poor nesting
Te Raurau	Any time	Island data sheets – presence/absence
Te Mangakiri	Nothing specific	Simply record details of mass mortality events
Te Karakara	May-June	Count nesting pairs Cook Is every few years
Te Matawa	Nothing specific	Island data sheets

In summary of Table 2.3, the highest priority sites for bird monitoring and pest surveillance are on the top ranked Te Ruru and Te Bwebwe Ni Marawa sites, (Motu Tabu, Big Drum, Big and SW Nimroona etc) and the mainland colonies of Tanguoua and Te Keeu.

3 SPECIES MONITORING GUIDELINES

This section provides specifics of monitoring for each species, including why, where, when and how, including data sheets.

3.1 Phoenix Petrel (PHPE, Te Ruru)

Question: Are PHPE numbers stable on CXI?

Why? PHPE is an endangered species with CXI supporting the largest global population. Risks include invasive pests (cats and rats) and poachers, also fluctuating food supply, perhaps also pollutants and long-line fishing.

What? Index the numbers of birds by counting the circling birds at the currently top 12 motu; if possible also estimate nesting productivity.

Where? The motu for counting circling Te Ruru are Motu Tabu, Motu Upua, Big Drum, Big Nimroona, SW Nimroona, S Nimroona, Iareto, Poland Channel 1 and 2, Isles a, Big Ambo and Tonga-Fred (refer maps, Appendix 3).

When? Annually on one evening per motu during Nov 25-Dec 15. This approach has been used with replicates in five years since 2011.

How? To estimate number of breeding pairs, count birds that are circling islands in the evening (1700-before dark, frontispiece). The number of circling birds correlates roughly with the number of pairs attempting to nest with 1 circling bird equating to 4-5 nesting pairs (Pierce and Brown 2011, R. Pierce pers. obs.). Collect additional information on nesting productivity on the same motu as often as possible by looking for signs of problems, such as predation by cats (partly eaten birds), rats (eaten eggs, scooped out with jagged edges, big-headed or other invasive ants attacking birds and eggs), poachers (beheaded and de-winged birds), starvation (skinny, dead or dying chicks), or entrapment (e.g. tangled in *Cassytha*). It is worth doing some of these observations late in the breeding season (e.g. March) to gauge whether there is significant chick mortality.

It is possible for one person to do all of Drum, Big Nimroona, SW Nimroona, S Nimroona, Iareto and possibly Tonga-Fred in one evening and for another person to use a motorbike do access sites for Big Ambo, Poland Channel Islands, etc. on the same evening. Viewing is best with the sun behind the observer. The best viewing sites for Big, Southwest and Little Nimroona are from opposite Little Nimroona. Poland Motu are best viewed from Poland Channel. South Nimroona, Drum, and other motu near Carver Way are all best viewed from Carver Way. Tonga-Fred is best viewed from Fisheries area. The best viewing site for Motu Upua is from a boat in the main lagoon. Motu Tabu is best viewed from the landing site. Some field training is needed - when counting Te Ruru it is easiest to use binoculars on birds undertaking upwind flights (which are slower than downwind flights) and begin with farthest upwind birds moving down to birds just starting on the upwind path, subtracting any estimated count overlap.

Data: Complete a data sheet each year, following the example below. Graph the counts in Excel each year as in Fig 3.1 below for 2011-17 to compare counts on the same motu from year to year.

Table 3.1 – Example of Te Ruru evening count data in 2011

Motu	Date	Time	Observers	No. PhPe	Weather/notes
Big Nimroona	1/12/11	1710	RP	450	440 at 1745; mod SE
SW Nimroona	1/12/11	1715	RP	240	210 at 1710; mod SE
Poland 1 north	1/12/11	1740	RP	126	mod SE
Poland 2 south	1/12/11	1745	RP	63	mod SE
S Nimroona	1/12/11	1820	RP	30	mod SE
Little Nimroona	1/12/11	1700	RP	15	mod SE
Big Drum	2/12/11	1715	RP	230	210 at 1815 mod SE
Isles a	2/12/11	1735	RP	50	mod SE
N of Nimroona	2/12/11	1755	RP	48	mod SE
W of Drum	2/12/11	1805	RP	38	mod SE
Carver 2b	2/12/11	1738	RP	8	mod SE

Isles b	2/12/11	1742	RP	13	mod SE
Carver1	2/12/11	1730	RP	3	mod SE
Motu Upua	6/12/11	1700	RP KK	130	mod SE
Motu Tabu	6/12/11	1735	RP KK	60	mod SE

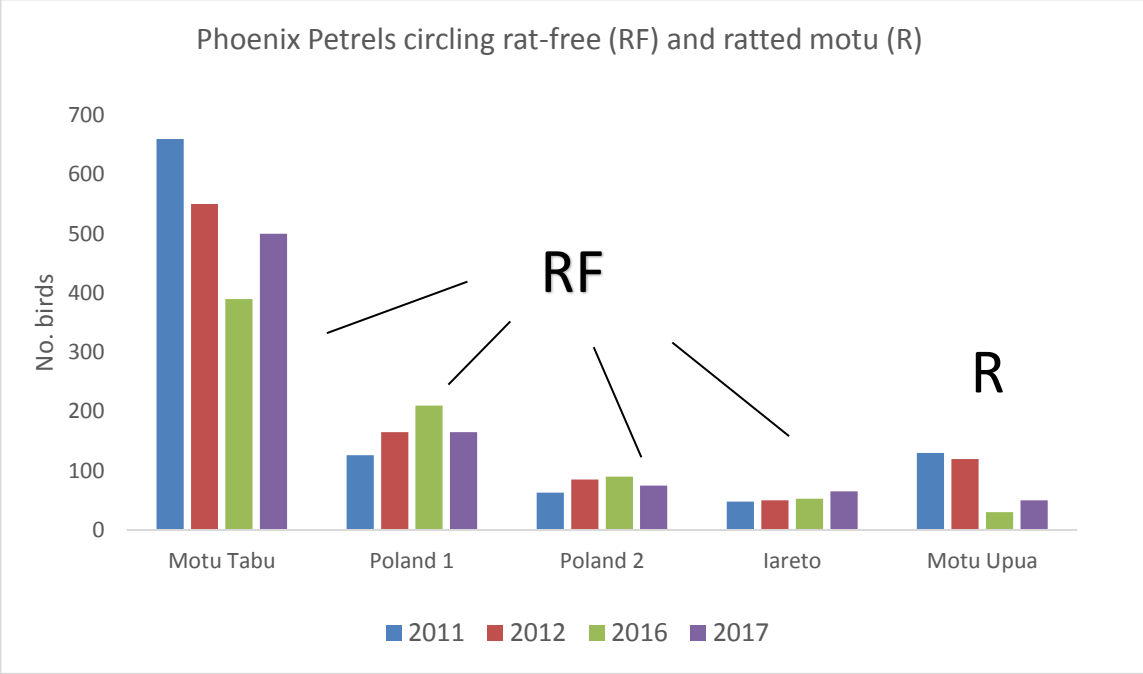


Fig 3.1 Evening counts of Te Ruru circling some key motu at Kiritimati in 2011-17.

3.2 White-throated Storm-petrel (WTSP, Te Bwebwe Ni Marawa)

Fig 3.3 - Te Bwebwe Ni Marawa at nest entrance in *Sesuvium*

Question: Are the motu used for WTSP in 2010-12 continuing to support this species each year?

Why? WTSP is an endangered species with CXI supporting the largest global population. Primary risks are invasive pests (cats and rats) but motu vegetation is also under threat from severe weather events.

What? Note the motu over which WTSP are seen hovering after sunset.

Where? As many of the small motu in the central lagoons as possible, also Manulu and Ava Lagoon area, Motu Tabu and any other motu where they are seen (refer map, Figure 3.4).

When? Annually on one evening per motu on any night in October-January. If nil return, repeat on another night.

How? By counting birds that are hovering over motu from 1800 h (about sunset) onwards. If you see WTSP on the first evening don't bother doing a second. Use binoculars; if it is too dark to see easily use a strong headlamp or spotlight. If you do not see WTSP landing at a regular traditional nesting motu after two nights, collect supplementary information in the following week by landing on the motu and looking for WTSP nests under grass/*Sesuvium*; also cats, rats, and signs of birds or eggs eaten by predators. Photograph motu vegetation (may need another day for better lighting).

Data: Complete a data sheet each year following the hypothetical example below.

Table 3.2 Example of Te Bwebwe Ni Marawa evening counts and nest searches in year (2012)

Motu	Date	Time	Observers	Min no. WTSP	Weather/notes
Carver1	12/12/12	1801-10	AT	0	Moderate E wind
Carver 2a	12/12/12	1814-20	AT	1	Moderate E wind
Carver 2b	12/12/12	1814-20	AT	3+	Viewed with binoculars
Carver 1	13/12/12	1820-24	AT	0	Light SE wind
Carver 1	14/12/12	1325-50	AT, KT	5 pairs	Landed and searched, 4 nests and 1 chick, no rat sign

Fig 3.4 -– grasses and mixed vegetation used by nesting petrels, shearwaters and storm-petrels on Big Drum, 15 Dec 2016. KK is pointing towards location of a concealed storm-petrel nest.

3.3 Christmas Island Shearwater (CISW, Te Tinebu)
3.4 Tropical Shearwater (AUSW, Te N'na)

Nothing specific needed for these species, but see under 3.6 Red-tailed Tropicbird for data to record on some motu. Te N'na has apparently greatly increased at CXI since the 1970s.

3.5 Wedge-tailed Shearwater (WTSW, Te Tanguoua)

Question: Can cat control on the mainland significantly improve WTSW survival and productivity?

Why? CXI formerly supported huge colonies of WTSW, but the mainland colonies have mostly gone because of predation by cats. WCU are testing whether of cat control at Big Peninsula will reduce cat-kills there.

What? Measure mortality rates of WTSW on the perimeter of colonies that are managed (cat control) and on pest-free motu. This will provide an index of predation pressure from cats. Also, carefully check within the nesting areas and rate burrow occupancy as 0, Low, Medium, High as this will give a better picture of how much breeding went on each year.

Where? Big Peninsula has been receiving cat control from 2013, while SW Nimroona will serve as a cat-free site. Probably not now worth comparing Tanguoua 1 near Drum Lagoon as non-treatment site as previously suggested, because too few Tanguoua now (2017).

When? In May and November of each year collect data on WTSW on the perimeter of all 3 colonies. Data from 2012 will serve as baseline data before cat control commences. Data from later years will test benefits of cat control.

How? In May carry out counts of dead Tanguoua around the perimeter of all sites – this is typically the 10 m or so wide perimeter of te ren and te mao bushes at the edge of the colonies as demonstrated in December 2012. Examine all birds and determine firstly if they are cat-kills (bite marks to skull +/-eaten flesh and visceral organs). Secondly determine if they are adults (paler plumage and worn wing feathers) or juveniles (darker, fresh plumage). Remove carcasses from the site to avoid later confusion. Note that the previous plan to measure productivity from borrows results in too much damage to the burrows, but as noted in "What" above, it is useful to have a look carefully within the nesting areas and rate nesting as 0, Low, Medium, High.

Data: Complete a data sheet twice for each year, following the example in Table 3.5 below and compare between the different colonies.

Table 3.5 – Tanguoua data

Site	Date	Obs	Cat-kills	Non-cat kills

			T adult	T juv	Te taake	T adult	T juv	Te Taake
Big Pen	2/12/17	AI BK RP	0	3	1	1	0	13 poach
Tanguoua 1	4/12/17	RP	0	5	0	0	0	0
Nimroona	30/11/17	AI KKT RP	0	0	0	1		1
Total								

Note: There is natural variation in productivity of Tanguoua in years because of variation in food abundance. In years with low food many dead chicks may be found even in colonies that are free of pests. Therefore, it is worth recording large mortality events – this is best done on predator-free motu such as SW Nimroona where the rat-free monitoring site will reveal any significant natural mortality.

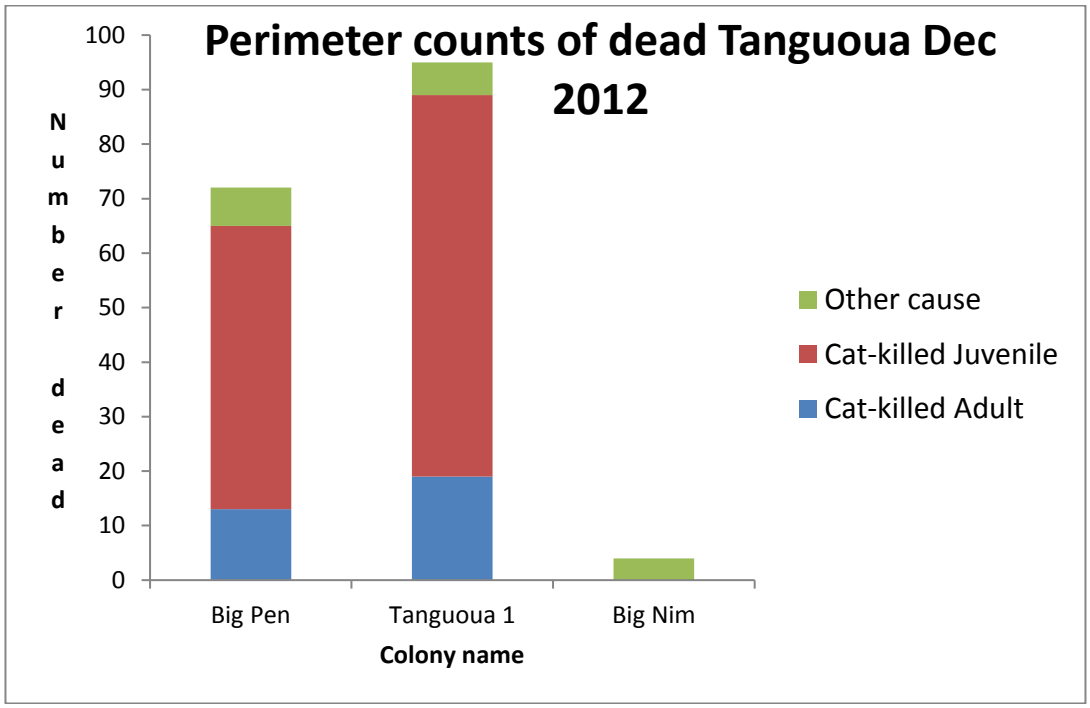


Fig 3.2 – Perimeter counts of dead Tanguoua at the study sites

Fig 3.4 – Te Tanguoua chick near fledging.

Multiple Species Monitoring
3.6 Red-tailed Tropicbird (RTTB, Te Taake)
3.7 White-tailed Tropicbird (WTTB, Te Ngutu)
3.8 Red-footed Booby (RFBO Te Koota);
3.9 Brown Booby (BNBO, Te Kibwi)
3.10 Masked Booby (MABO, Te Mouakena)
3.11 Great Frigatebird (GRFB, Te Etei Are E Bubura)
3.12 Lesser Frigatebird (LEFB, Te Etei Are E Aki Rangi Ni Bubura)

Questions: Are the numbers of tropicbirds, boobies and frigatebirds stable on CXI? Is poaching a local problem or is it pervasive throughout CXI?

Why? CXI is an important breeding site for Red-tailed Tropicbirds, three species of boobies and two species of frigatebirds. However, poaching levels are serious and threaten the populations of these species at least locally. There have been recent efforts to stop poaching, and there is a need to monitor outcomes of these anti-poaching efforts.

What? Monitor nesting colonies and concentrations of these species in key areas, focusing on the highest value sites and sites known to be prone to poaching.

Where? SW Nimroona, Big Nimroona, Drum, Frigatebird Island (Koil Lagoon), Isles Lagoon, Big Peninsula, Cook Island, Ambo, Tibo.

When? Twice each year, in May-June and November-December (few Te Taake likely to be present in November-December).

How? Perimeter counts done by two people working together - one person walking on the outer side of the trees and one on the inner side of the trees. As you walk the perimeter, count all nests of each species and note their contents (adult, adult with egg, adult with small chick, adult with large chick, dead chick, unknown). Also record the number and species of any dead birds that have evidence of poaching (decapitated, wings removed, etc.) as per data sheet. For the locally rare WTTB simply keep incidental records of sightings. For Mouakena, which is large and easily visible but sparsely distributed, explore options for aerial monitoring.

Data: Complete a data sheet for each visit, following the example below in example of standard island data sheet below. Note that these data can subsequently be used for monitoring as per species graphs that follow.

Fig 3.5 – The unsavoury task of sorting poached birds

Table 3.4. Example of data collected during multiple species monitoring on motu

Lagoon	Nimroona	Nimroona	Nimroona			
Motu	SW	SW	Big			
Area (ha)	3.9	3.9	6.5			
Date	26/11/11	1/12/11	26/11/11			
Time	1315-1500	1200-1800	1315-1500			
Observers	AT AI DB RP	AI RP	AT AI DB RP			
Kimoa/rat sign	0	0	0			
Cat sign	0	0	0			
Poaching	29; 13 Koota 15 Taake 1 Etei	0	74; 55 Koota 12 Taake 7 Etei			
Te Ruru	68-160 F	1100 p	105-260 F			
Te Tanguoua	P	P	P			
Te Tinebu	P	P	P			
Te N'na	P	P	P			
Te Bwebwe	-	1 p	-			
Te Taake	7 p (x nests, y J)	7 p	9 p			
Te Mouakena	0	0	1J			
Te Kibwi	0	0	0			
Te Koota	3 p (x nests, y J)	3 p	25 p			
Te Etei area	0	0	3 i			
Te Etei rangi	0	0	0			
Te Karakara	0	0	1			
Tarangongo	0	0	400+ p +many juvs			
Te Keeu	1	0	0			
Te Io	0	0	0			

Te Mangakiri	1 p	2 p	2 p			
Te Raurau	2 p	2 p	1 p			
Te Matawa	c.5 p	c.5 p	c.10 p			
Te Kewe	0	0	0			
Bokikokiko	0	1 i	1 i			
Skink	c.10	30+	c.20			

Key: P = present – not counted, Numbers = pairs (p) or individuals (i), J = juvenile, F = flying overhead; underlined = breeding

Observers: Ateata Ioine, Derek Brown, Ray Pierce, Aobure Teatata

Notes:

Nimroona - No sign of rats or cats – scores of abandoned eggs intact or with small holes, some crunched possible by te kewe; many carcasses examined showed no rat or cat gnaw marks.

SW Nimroona gap still c.20 m, windy site with small waves has stopped kimoa colonization for 2.5 years.

Many dead Te Ruru, some tangled in *Cassytha*

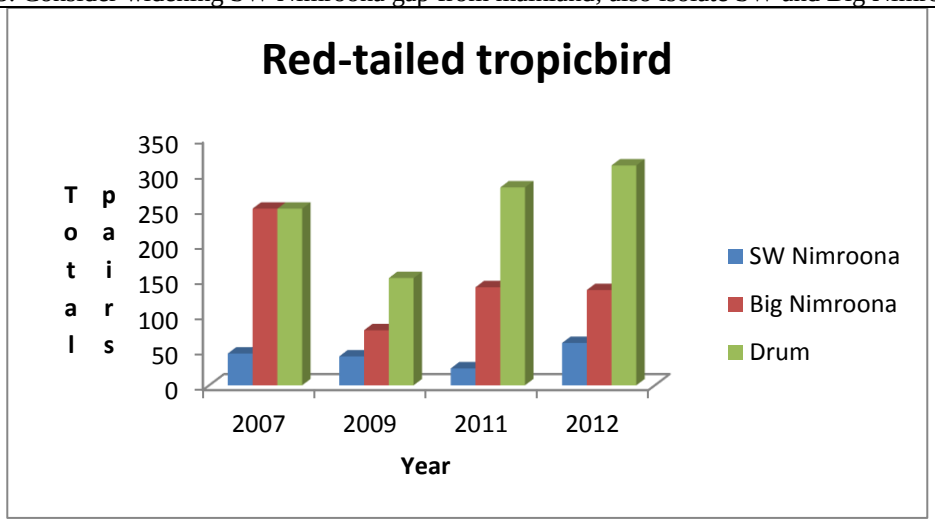
Poaching – 103 dead birds decapitated and de-winged most from past few weeks, some older.

Risks – now that te etei, te koota and te taake are virtually wiped out here the poachers are likely to target others especially the Endangered Te Ruru and possibly switch to additional motu.

Survey of Te Ruru 1/12/11 revealed 613 nests with bird and/or egg present + 491 active unoccupied nests in middle of day (total 1100+ pairs). Circling birds overhead peaked at c.240 for SW Nimroona and c.440 over Big Nimroona at 1745 h (observation time 1145-1800).

Action needed

1. Anti-poaching vigilance – now that most large birds are gone from Nimroona due to poaching, Te Ruru may well be next on the menu there and possibly other lagoon islands poached e.g. Drum, Tonga-Fred, Koil etc. Needs pressure on poachers (by WCU) and on Government to remove squatters (Ray) and DOC visit (Ray).
2. Increased surveillance for rats/cats and birds (Ray is drafting a monitoring document).
3. Consider widening SW Nimroona gap from mainland; also isolate SW and Big Nimroona by digging gap



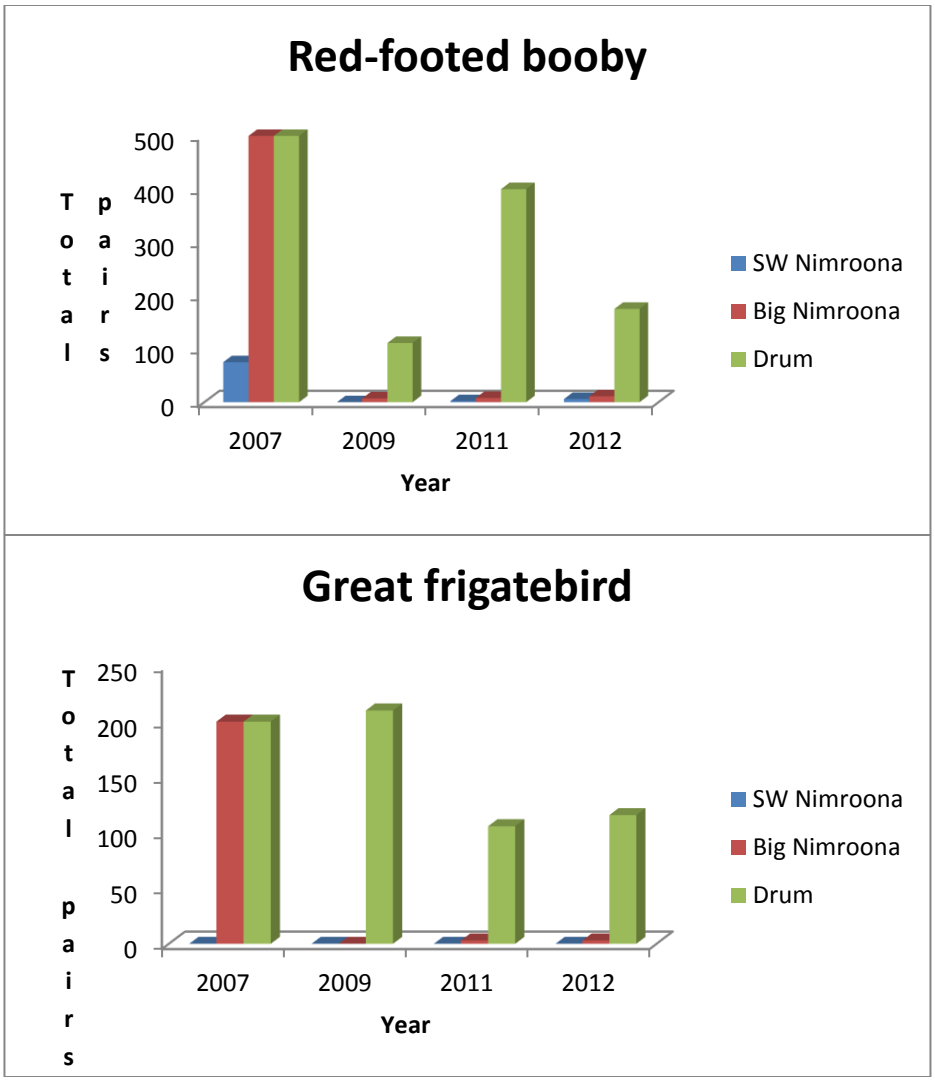


Fig 3.6 –Trends in numbers of breeding pairs of Te taake, Te Koota and Te Etei in June on two heavily poached motu (SW and Big Nimroona) and unpoached Big Drum (green bars). Only Big Drum has kept high numbers over this five year period, probably due to difficulty of human access.

3.13 Sooty Tern (SOTE, Te Keeu)

Question: Are SOTE continuing to decline at CXI since the 1980s?

Why? CXI supports some of the largest SOTE colonies in the world but there are no recent data on colony size or bird numbers and trends.

What? Map the perimeter of each colony to measure its size. Measure the density of nests in each colony and calculate the total number of birds. Revisit late in season to gauge any mass mortality.

Where? All colonies - Cook Island, Motu Tabu, Main Camp area, Cassidy Airport area, SE Peninsula (2-3 colonies).

When? At the end of the egg-laying periods, usually in June and December but may be in other months.

How? Walk the perimeter of each colony while recording a GPS track and use this to calculate area. As time permits, also measure density of each colony using at least two transects at random locations in each colony. Each transect is 2 meters wide and should be at least 10 meters long, measured with a 2-meter pole held horizontally with ropes hanging down to determine if nests are inside the transect. Use a tape measure to measure length of each transect and a GPS to record the location. Count the number of nests inside the transect and divide by the area to calculate the nest density. The total number of nests in each colony can then be estimated by multiplying the size of the colony with the density of nests.

Data: Complete a data sheet each year, following the example in Table 3.5. Compare size and density of colonies with those of the past.

Table 3.5 – Example of Sooty Tern Colony data

Colony name	Date	Area (ha)	Nest density (# per ha)	Total # of nests	Observer, notes
Cook I	June 1982	10.25			WCU Report #10
NW Pt	June 1982	4.81			WCU Report #10
K Site	June 1982	13.0			WCU Report #10
Cook I	Nov 2017	<5			KK maps
Motu Tabu	Nov 2017	< 1			KK maps
Mouakena	Nov 2017	10+			KK maps
Notes: record GPS locations of transects here.					

3.14 Great Crested Tern (GCTE, Taranui)

Questions: Are GCTE stable as a breeding species and are they productive?

Why? Only a single colony exists at CXI, on Cook Island. Regular counts were made in the past.

What? Count the number of nesting pairs in the colony and later the number of late stage chicks.

Where? Cook Island.

When? Every year or every second year at the end of the laying period and again before the peak fledging (young flying). The timing of nests may vary among years; therefore, the behaviour of birds and stage of nesting could be quickly observed during patrols to Cook Island in order to make sure visits are made at the best months.

How? Using binoculars from a distance.

Data: Complete a data sheet each year following the example in Table 3.6 below. Compare numbers of pairs and productivity with those of the past. Wildlife reports from the 1980s suggest the colony was larger than it is now.

Table 3.6 – Example of Cook Island Great Crested Tern data to record				
Date	No. nests or pairs	No. chicks	No. flying young	Observers/notes

3.15 Grey-backed Tern (GBTE, Tarangongo)
3.16 Blue Noddy (BLNO, Te Raurau)
3.17 Brown Noddy (BNNO, Te Io)

Question: There are no specific questions about these species but all three are very useful as indicators of rat presence/absence. For example, they may be useful indicators on important storm-petrel motu.

Why? As ground nesters they are especially vulnerable to rats and can indicate a problem more readily than burrow nesters like the petrels.

What? Quick surveys to determine overall colony health and presence of rats. Integrate with motu surveys (see above). If rats are thought to have invaded an motu, look for the nests and chicks of these species. If rats are present, there probably will be total colony failure. If these species nest successfully, rats are unlikely to be present.

Where? Most useful on the priority one motu of the central lagoons.

When? Any time but do formal assessment mid-year (May-July) on each Priority 1 motu.

How? Ground search, count the number of adults, nests and chicks.

Data: Enter on the standard island data sheet (Appendix 2.3) and use these data as a guide to interpreting whether rats are present on the motu.

Fig 3.7 – The presence of many tern chicks and/or intact eggs is a good sign that rats are absent or rare.

3.18 Black Noddy (BKNO, Te Mangikiri)
3.19 White Tern (WHTE, Te Matawa)

Question: There are no specific questions for WHTE. Are BKNO being poached? Does mass failure of BKNO colonies coincide with certain oceanographic conditions or weather patterns?

Why? Noddies may be susceptible to poaching and they can also be good indicators of food abundance.

What? Look for fire pits with bones around. Look for mass mortality events, e.g. chick starvation.

Where? Motu with trees.

When? Any time.

How? Search the ground below nest trees for dead birds and nearby areas for fire pits.

Data: Enter on island data sheet.

3.20 Bokikokiko/Christmas Island Warbler (BKKO, Bokikokiko)

Question: Are BKKO holding their own or are invasive species and habitat changes impacting the population?

Why? Most of the global BKKO population occurs on CXI, but WCU have also confirmed

presence on Terraina (R. Bebe, pers. comm.). On CXI BKKO are distributed widely but patchily, mainly in habitat containing tall te ren and te mao, with ten teneni also present; few are present on the SE Peninsula. Recent monitoring has suggested that the population is relatively stable, but monitoring needs to be continued particularly given the uncertain status of *Rattus rattus* on the island. The focus should be on **pairs** of Bokikokiko given that incubating females are likely to be most vulnerable to predation.

What? BKKO monitoring stations along established transects and establish new transect lines at Terraina.

Where? Crystal Beach, two coastal lines (*Rattus rattus* present), Bathing Lagoon (in sparse coconut plantation), Kammaraki (inland line) and Tanguoua area (apparently free of *Rattus rattus*). Also, every 5 years or so, check some of the 2007 sites, including Tabwakea East, Y-site and Poland.

When? Aim for 1 May – 30 June annually.

How? Transects should have 10 stations (habitat permitting) at 200 m intervals.

- Use the MP3 player and speaker and new digital audio files recorded in 2012. Recharge the MP3 player before each use by plugging it into a computer using the USB cable. The speaker requires a 9-volt battery.
- 3-4 observers with binoculars.
- Play audio soon after arrival at station (record weather etc. data last)
- Play audio at Volume 15 on the new player, while the observer rotates 360 degrees
- Look and listen throughout the 1 minute of audio playing and also the following 2 minutes, for a total of 3 minutes.
- Observers look/listen in different sectors to maximize coverage.
- Once a single bird is detected, one person focuses on that bird to see if it is joined by a mate, while other observers scan more widely, using binoculars to check distant (>100 m) perches, typically tall te ren, isolated te mao, etc.
- **Record number of pairs** as well as total number of individuals per station.
- Note if pairs/individuals at a station are considered to be the same as any birds observed at the previous station. Nearly all resident birds respond to this approach, usually in 30 seconds or less (E. VanderWerf in Pierce et al. 2007; VanderWerf and Young 2007).

Data: see sheet below. Graph in XL total counts per transect line and year to year and also the number of pairs.

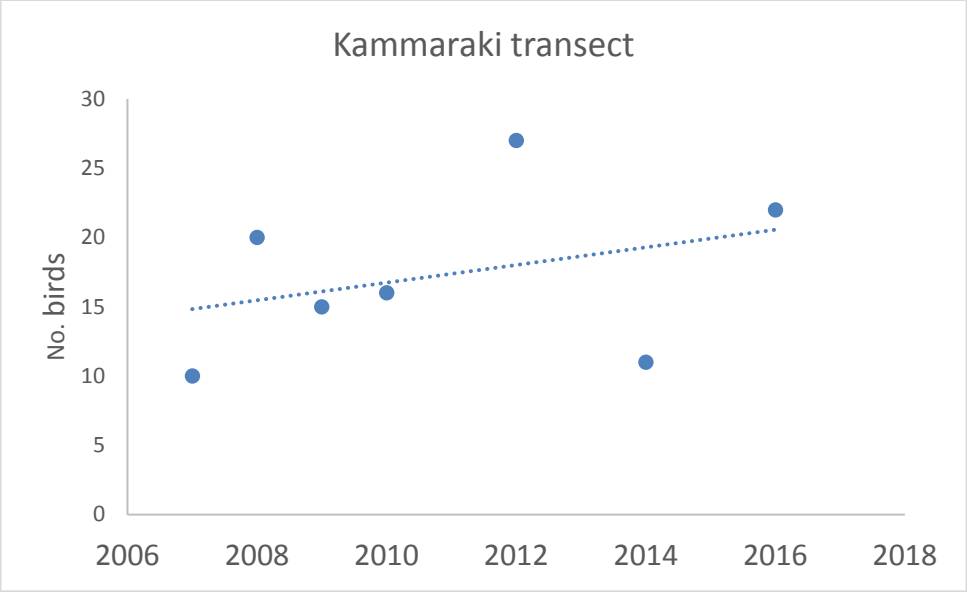


Fig 3.8 – Counts of Bokikokiko at Kammaraki 2007-16. The trend line is line of best fit (XL)

Note that the removal of rats from the Nimroona islands is providing an opportunity to measure Bokikokiko responses to rat removal and subsequent reinvasion. Staff should count Bokikokiko on routine surveillance there to see if the colonization of the islands continues.

4 INVASIVE SPECIES SURVEILLANCE GUIDELINES

4.1 General

Rank 1 and rank 2 motu are all at risk from invasives getting ashore and many are also at risk of poaching. The three key invasive species are Pacific rat (*Rattus exulans*), black rat (*Rattus rattus*) and feral cats (*Felis catus/silvestris*). Here Pacific rat and black rat are lumped together as sign is relatively similar, but additional mainland searches should be made for *Rattus rattus*. During all visits to motu, carefully search for sign of rats, cats or poaching, i.e. get into a search routine, looking for eaten birds or their eggs, darting rats, droppings of cats, etc.

4.2 Rats

The tell-tale signs of rats on the CXI motu are as follows:

- Eaten eggs of terns and petrels in which the contents are cleaned out and the broken edges of the shell are finely jagged where the rats have nibbled round the shell to break inside (Fig 4.1). On motu where there are no rats any abandoned eggs are typically intact or with cracks, while some have narrow slices where perhaps invertebrates have gained access into the egg
- Gnawing (fine pairs of tooth marks) on bones of recently dead birds where the rats have scavenged

meat from a carcass.

- Gnawing on succulent plants – again look for fine scratch marks from teeth
- Sightings of rats – kimoa (Pacific rats) are quite active from about 4 pm onwards so it is important to time visits to Rank 1 motu late in the day to maximize the chances of detecting rats. Take a torch in case you are uncertain about rat status and need to stay and spotlight after dark just to make sure.

Fig 4.1 – classic kimoa gnawing on Te Tarangongo eggs

Some additional survey work is justified for *Rattus rattus* given that their arrival on the small motu in Motu Tapu and the central lagoons area would be devastating for Te Ruru, Te Bwebwe and others. At key points (Carver Way, Motu Su) undertake trapping with 20-25 Victor traps for 4-5 nights using cooked coconut bait on elevated traps. This can be done at any time of year, but soon after the wet season (when there is freshwater available) may provide optimal conditions for dispersing rats.

4.3 Cats

- Partly eaten carcasses of petrels, shearwaters, noddies, etc. Fresh kills will show characteristic opening of the body cavity (Fig 4.2). Fresh or older kills may also show head being crunched. In all cases the bones are crushed as opposed to just gnawing by rats.
- Eggs including large eggs of boobies and frigatebirds can be broken open and the contents eaten. Typically, these eggs have larger jagged bits than those of rat gnawing and often the remaining shell is flattened from the force or weight of the cat.
- Sightings of cats – cats are frequently seen about the same time one notices the dead birds.
- Scats or droppings – keep a sharp eye out for droppings and scratching at latrines.
- Footprints, especially in sandy areas and shorelines.

Fig 4.2 – Decapitated Te Tanguoua chick with body cavity opened, typical cat-sign.

4.4 Invasive ants

Kiritimati was invaded by Yellow Crazy Ants in about 2013 and these have been targeted for eradication by WCU under the guidance of Pacific Biosecurity. To date (December 2017), the lack of YCAs is promising, but surveillance is needed for at least another year as per Table 4.4.

Table 4.4 – YCA Surveillance Timetable for 2018

Date	Activity	Comment
February 2017	Visual search on noni	
May 2017	Visual search and lures	Coincide with visit by M Gruber
May 2017	Survey Terraina, Tabueran	Coincide with visit by M Gruber
August 2017	Visual search	
November 2017	Visual search and lures	Coincide with visit by R Pierce

Also maintain surveillance for invasive ants at ports as guided by Pacific Biosecurity and awareness programmes throughout community. Examine nests and carcasses on Motu Tabu and other motu for sign of invasive ant incursions, including Big-headed ant (*Pheidole megacephala*).

4.5 Poaching

- Decapitated and de-winged large birds, typically tropicbirds, boobies and frigatebirds.
- Sometimes small birds like black noddies are also taken and cooked on the spot in fire pits.
- Some poachers are suspected of removing the whole bird from the island, so other sign is needed, e.g. broken twigs, footprints, burrows that are dug up, and the counts of live tropicbirds nesting in May-June.

Table 4.1 – Some characteristic sign in relation to rats and cats (from Pierce and Brown 2012)

Evidence:	Rats/cats absent	Rats present	Cats present
Abandoned eggs	Intact or cracked, often small holes from insects, lizards. Hatched eggs have coarsely jagged edges, egg membrane in one piece	Few intact eggs; many eaten eggs with finely jagged edges (fig 4.1), interior cleaned out, rat droppings	Egg shells crunched inwards (not stabbed like curlew bill stab)
Dead seabirds	Intact, i.e. no biting or gnawing by toothed critters	Rodent tooth marks on bones – usually fine scraping	Crunched head, breast meat/organs eaten;
Other	-	Gnawing on succulent plants	Scratching, latrines

5 ANNUAL MONITORING SUMMARY

The Table below identifies the months in which monitoring and surveillance should be completed. Dark shades are the Rank 1 species (PHPE, WTSP, BKKO) and the rank 1 motu of Motu Tabu, Cook, Drum, Nimroona, etc. Light shades are for the rank 2 species and sites.

Species/group/site	J	F	M	A	M	J	J	A	S	O	N	D
Te Ruru												
Te Bwebwe ni Marawa												
Bokikokiko												
Motu Tabu/Cook												
Drum/Nimroona												
Tanguoua												
Te Keeu												
Te N'na/Te Tinebu												
Te Taake, frigates, boobies												
Other terns/Noddies												

6 USING THE INFORMATION

6.1 Data

Clean copies of data sheets are provided in Appendix 2. It is important that the data collected in the field are kept in safe places, firstly on hard copy field data sheets and secondly in electronic files such as Word documents or Excel spreadsheets, following the species and island examples given in Section 3. The electronic versions should be sent to ECD Tarawa and to support agencies (EOPL, SPREP, PII) as backup.

6.2 Analyses

These are simple and are easily completed by graphing in Excel the counts over the years and looking for trends in the counts – refer to Fig 6.1 example below for Te Ruru and for others in Section 3. Others do not require analysis, e.g. presence of predator sign on an island, but clearly a response is needed (see below).

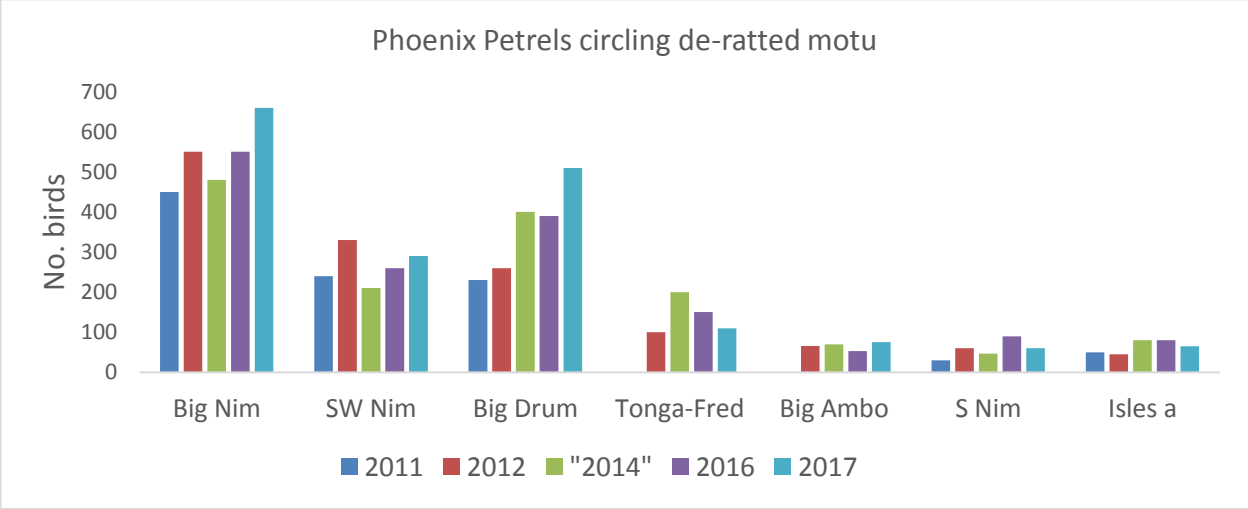


Fig 6.1 – Example of graphed trend counts to date for Te Ruru at de-ratted motu.

6.3 Responses

Some possible monitoring outcomes are provided in the table below together with appropriate management responses:

Monitoring finds:	Management response:
Rat sign on Rank 1 motu	Implement rat contingency plan, i.e. bait the motu following best practice developed in 2009 CXI motu baiting
Cat sign on Rank 1-2 motu	Remove cat immediately using local best practice – running down, shooting, traps

A count on one of the Bokikokiko transects is half that of the previous year's count	Repeat the transect count within a few days to test if the low count is real. If the 2nd count is higher, nothing further is required, but if the count is low again, implement a rat trapping index line through the same area to gauge if rats have invaded the area - if they have, seek management advice
Poaching sign on a Rank 1 motu	Set up appropriate surveillance as per guidelines from impending law enforcement training June 2012

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APPENDIX 1 - KIRITIMATI BIRDS

Species	Kiribati name	English name
Pterodroma alba	Te Ruru	Phoenix Petrel
Puffinus pacificus	Te Tanguoua	Wedge-tailed Shearwater
Puffinus nativitatis	Te Tinebu	Christmas Shearwater
Puffinus tropica	Te N'na	Tropical Shearwater
Nesofregetta fuliginosa	Te Bwebwe Ni Marawa	White-throated storm-petrel
Phaethon rubricauda	Te Taake	Red-tailed Tropicbird
Phaethon lepturus	Te Ngutu	White-tailed Tropicbird
Sula dactylatra	Te Mouakena	Masked Booby
Sula leucogaster	Te Kibwi	Brown Booby
Sula sula	Te Koota	Red-footed Booby
Fregata minor	Te Eitei Are e Bubura	Great Frigatebird
Fregata ariel	Te Eitei Are e Aki Rangi Ni Bubura	Lesser Frigatebird
Pluvialis fulva	Te Kun	Pacific Golden Plover
Numenius tahitiensis	Te Kewe	Bristle-thighed Curlew
Heteroscelus incanus	Te Kirikiri	Wandering Tattler
Arenaria interpres		Ruddy Turnstone
Sterna bergii	Te Karakara	Great Crested Tern
Sterna lunata	Te Tarangongo	Grey-backed Tern
Sterna fuscata	Te Keeu	Sooty Tern
Anous stolidus	Te Io	Brown Noddy
Anous minutus	Te Mangikiri	Black Noddy
Procelsterna cerulea	Te Raurau	Blue Noddy
Gygis alba	Te Matawa	White Tern
Vini kuhlii	Te Kura	Rimatara (Kuhl's) Lorikeet
Acrocephalus aequinoctinalis	Bokikokiko	Christmas Island Warbler

APPENDIX 2 – CLEAN DATA SHEETS

2.1 Te Ruru evening count data in year ( )					
Motu	Date	Time	Observers	No. PHPE	Weather/notes

2.2 Te Bwebwe Ni Marawa evening counts and nest data in year ( )					
Motu	Date	Time	Observers	No. WTSP	Weather/notes

2.3 Multi-species Island data sheet

Lagoon						
Motu						
Area (ha)						
Date						
Time						
Observers						
Kimoa/rat sign						
Cat sign						
Poaching						
Te Ruru						
Tanguoua						
Te Tinebu						
Te N'na						
Bwebwe ni m						
Te Taake						
Mouakena						
Te Kibwi						
Te Koota						
Te Etei area						
Te Etei rangi						
Te Karakara						
Tarangongo						
Te Keeu						
Te Io						
Te Mangikiri						
Te Raurau						
Te Matawa						
Te Kewe						
Bokikokiko						
Skink						

Key: P = present – not counted, Numbers = pairs (p) or individuals (i), J = juvenile, F = flying overhead; underlined = breeding

Observers:

Notes:

2.4 –Sooty Tern Colony data sheet					
Colony name	Date	Area ha	Nest density (# per ha)	Total # of nests	Observer, notes

2.5 – Tanguoua data								
Site	Date	Obs	Cat-kills			Non-cat kills		
			T adult	T juv	Te taake	T adult	T juv	Te taake
Big Pen								
Tanguoua 1								
Nimroona								
Total								
Notes								

2.6 Bokikokiko survey data sheet

Transect name:				Date:		Observers:														
Stn. no.	GPS reference		Time start	Total no. of pairs and total birds	Details of birds	Weather			General habitat Openness 0 = mostly bare, 4 = dense vegetation			% plant cover: bare = rock, coral, sand, water, tm= te mao, tr= te ren, g = grass, tt = ten tanini tn=te nii , tabeua riki=tb ta=te aroua , 8= ✓ = present but <5%								
	N	W			Ad/H, Ad/S, 2Ad/S, J/H, J/S, etc	Wd 0-4	Cld 0-4	Rn 0-4	Open-ness 0-4	Av ht (m) te mao	Av ht (m) te ren	Bare	tm	tr	g	tt	tn	ta	7	8

Notes:

APPENDIX 3 - PHOTOS OF SOME MOTU USED BY WHITE-THROATED STORM-PETREL IN 2016-17. See also Fig 3.4.

1. E Manulu Lagoon, 3 December 2017. Henry's Motu – only *Sesuvium* and debris providing cover.

2. North Manula Lagoon, 3 December 2017 - *Sesuvium* and grass cover

3. South Manula Lagoon, 3 December 2017 – *Sesuvium, Sida* and grass cover

4. S Manulu Lagoon 3, December 2017 – mixed vegetation

5. SW Nimroona (3.9 ha), 30 November 2017 grasses, *Boerhavia and Cassytha*