

SUMMARY OF RESTORATION WORK UNDERTAKEN ON THE PHOENIX ISLANDS ATOLLS, KIRIBATI IN JULY 2011



Ray Pierce and Derek Brown

With support from Stacie Hathaway, Andrew MacDonald, Katareti Taabu, Nick Torr and Graham Wragg and the crew of MV Aquila and pilots and ground staff of Pathfinder Aviation and Heli-Otago Ltd

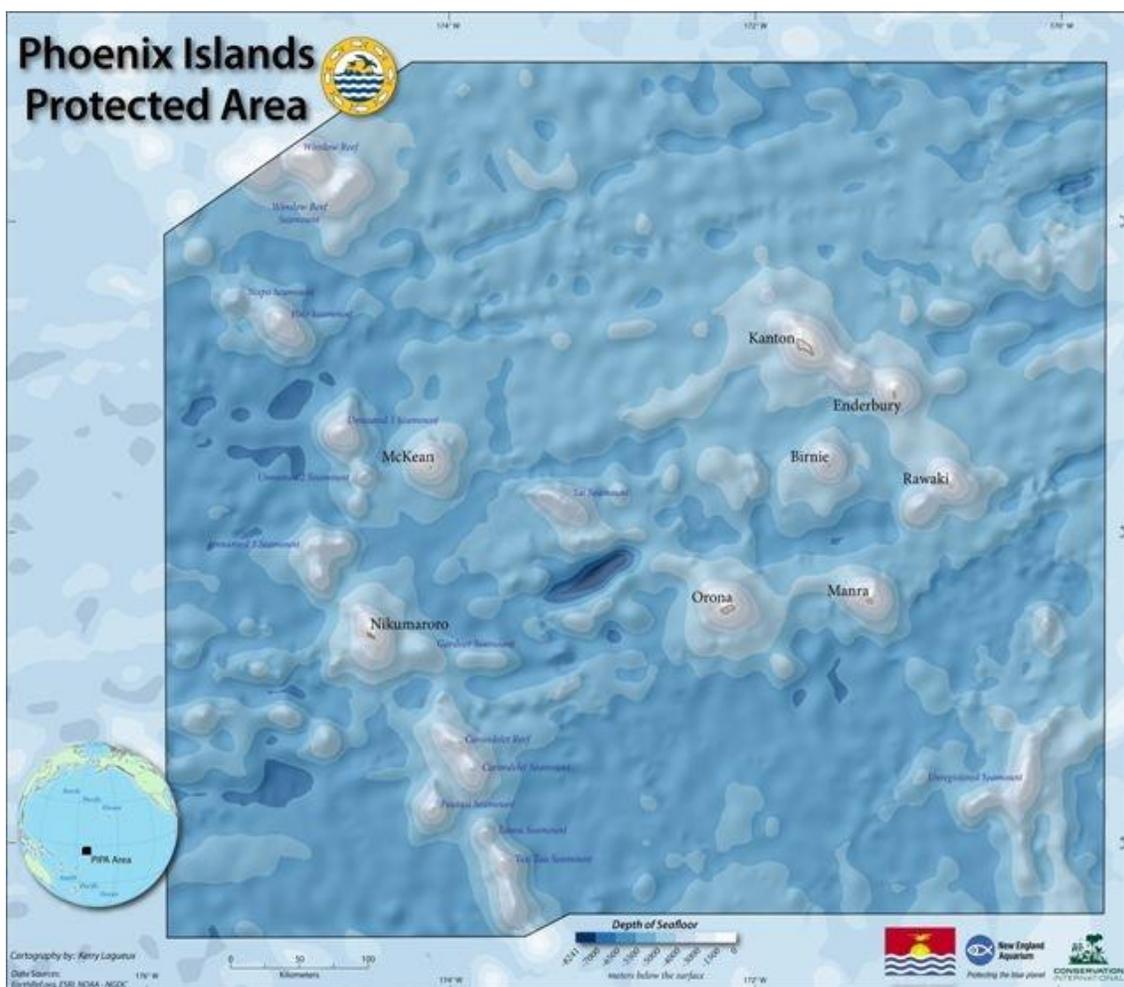
August 2011

Eco Oceania Pty Ltd Report for Government of Kiribati, CI - CEPF,
and Packard Foundation

CONTENTS

1.0	BACKGROUND AND 2011 OBJECTIVES	4
2.0	RAT ERADICATION OPERATIONS AT ENDERBURY AND BIRNIE	5
3.0	BIOTA OF ENDERBURY AND BIRNIE	8
4.0	PEST-FREE RAWAKI	12
5.0	KANTON AND MANRA SURVEYS	15
6.0	DISCUSSION AND RECOMMENDATIONS	18
	ACKNOWLEDGEMENTS	19
	REFERENCES	19
	APPENDIX 1 - field timetable July 2011	20

Frontespiece - birds returning to Rawaki at dusk and moonrise (Kale Garcia)



1.0 BACKGROUND AND 2011 OBJECTIVES

This report summarises work undertaken to eradicate Pacific rats (*Rattus exulans*) on Enderbury and Birnie Islands and associated restoration work in the Phoenix Islands Protected Area (PIPA) in July 2011; and provides recommendations for further work.

The Phoenix Islands are a World Heritage Area and also have many other international designations including Key Biodiversity Area and Important Bird Area reflecting the exceptionally high diversity and abundance of marine and terrestrial biota. The terrestrial values are summarized in Table 1 and include globally important seabird colonies spanning 19 species of petrels, storm-petrels, frigatebirds, boobies, tropicbirds and terns, including the Endangered Phoenix petrel and white-throated storm-petrel which are largely confined to Rawaki. However, a fundamental problem facing these seabirds and terrestrial biodiversity in general has been the presence of 1-3 invasive vertebrate species on each of the 8 islands, with only Rawaki not having been invaded by rats.

Island	Approx land area	Habitat diversity	Seabird spp	Vertebrate invasives
Rawaki	47	Moderate	17	Rabbit to 2008
McKean	21	Moderate	15+	Asian rat 2001-2008
Enderbury	550	High	15+	Pacific rat
Birnie	49	Low	10+	Pacific rat
Kanton	900*	High	10+	Cat, black and Pacific rats
Manra	500*	High	10+	Cat, black and Pacific rats
Orona	600*	High	10+	Cat, Pacific rat
Nikumaroro	400*	High	8+	Pacific rat

Table 1 – Summary of island area, habitat, seabird and pest status (green shading = invasives removed, yellow = operational work to remove invasives completed)

A key turning point occurred in 2006 when a conservation survey assessed the feasibility and priorities for terrestrial restoration work with Rawaki and McKean being considered the two top priority islands for pest removal¹. Table 2 summaries the ensuing approaches to remove the invasive vertebrate threats on the PIPA islands, beginning with the successful removal of rabbits and Asian rats from Rawaki and McKean Island respectively in 2008, but the third target island, Birnie, proved too dangerous to treat at that time. This work was followed by planning for the eradication of Pacific rats on Enderbury and Birnie⁶ together with the improvement of biosecurity on vessels visiting or passing through the PIPA⁷.

Year	Funder	Key outcomes (and reference – see literature cited)
2006	CEPF	Seven islands surveyed for restoration opportunities (1)
2007-8	NEAq	Planning for pest eradications (2), management planning (3)
2008	NZODA/MFAT/ NZDOC	Rabbits and Asian rats eradicated on Rawaki and McKean respectively (4)
2009	CEPF	Rawaki and McKean eradications declared successful; restoration studies on Enderbury, Birnie, Orona, Kanton (5)
2010	CEPF	Planning for Enderbury-Birnie rat eradications (6); PIPA biosecurity guidelines (7)
2011	Packard, CEPF, GEF	Enderbury-Birnie rat eradications; biota and pest surveys of these atolls plus Rawaki, Manra, Kanton

Table 1 - A summary of terrestrial restoration work achieved at the PIPA to date
Note CEPF = Critical Ecosystem Partnership Fund, Packard = Packard Foundation,
NZODA/NZAID = NZ Overseas Development Agency now a division of MFAT or
Ministry of Foreign Affairs and Trade.

2011 objectives

The objectives of the work in 2011 were as follows:

- to bait Pacific rats on Enderbury and Birnie Islands
- to build on existing baseline data on biota at Enderbury-Birnie
- to assess responses of biota on Rawaki post-rabbit
- to evaluate feasibility of eradicating invasives from Manra and Kanton
- to assist GoK staff in biodiversity recovery work at Phoenix Islands.

2 RAT ERADICATION OPERATIONS AT ENDERBURY-BIRNIE

Planning

Fundraising began in early 2010 with financial support being provided by the Packard Foundation in mid 2010 followed by CEPF and GCF in early 2011. The total budget was c.USD800,000. Delays in appointment of the PIPA Trust's Director led to a NEAq being assigned administrative role for the Packard funds, while CI/CEPF provided direct support to PEL and EOPL.

The first draft of the operational plan was completed by DB on 5 March 2010. Subsequent updates were completed following confirmation of plans to collaborate with Palmyra and Henderson Island rat eradications and again following an external review from the Island Eradication Advisory Group of NZDOC and other minor revisions.

The Government of Kiribati provided permits for visiting the PIPA, bait importation, bait application, helicopter clearance, collection of physical and biological samples. A MELAD staff member, Katareti Taabu, participated in the field operations.

Considerable preparation was undertaken by colleagues leading up to the PIPA

eradication work including:

- MV Aquila – modification for heli pads, bait containers etc
- Pathfinder and HeliOtago – preparation of helicopters, GPS and buckets, etc
- Palmyra and Henderson staff involved in the collaboration.

Broadly the planned operational approach for Enderbury and Birnie islands was to use PestOff 20R baits containing 20 ppm brodifacoum in 2 gm pellets. The PestOff was shipped in 25 kg bags in containers from New Zealand to Apia, Samoa, where it was then loaded aboard the MV Aquila in early July 2011. . Off each island bait was loaded into buckets on the purpose-built Aquila heli-deck from where the two Bell 206B (Jet Ranger) helicopters would lift the buckets to drop bait across the islands – a first application was planned at c.20 kg/ha and a second c. 1 week later would be c.10 kg/ha.



Fig 2.1 – helicopters on one of two modified heli-decks on the Aquila

Birnie

The first baiting at Birnie took place on 14 July 2011 and the second on 19 July (Samoa time). The treatment area was assessed as 49.4 ha, and 1,225 kg was applied in a single afternoon for the first application. Nominal sowing rate was intended as 10 kg/ha out of the bucket, with 50% overlap in swath widths (meaning an ‘on-ground’ rate of 20 kg/ha on inland areas, with an additional swath around the coast). Actual baiting rates averaged 24.8 kg over the entire island, with greatest concentrations around the coast.

Swath width from the bucket was established on the first bait run, with swath width of

85m being noted, so the conservative and desired minimum swath width of 80 m was used for our baiting calculations.

Loading occurred from the heli-deck of the ship whilst the ship was ‘jogging’, as it was initially considered that anchoring was not possible, but for all later baitings (the second at Birnie and both at Enderbury) the ship found suitable anchorage which further assisted efficiency of the operation. Longer lifting strops had been previously put on the bait buckets (8 m versus the standard 5 m) to allow for greater clearance of the helicopter above the deck while the bucket was being filled. The standard loading procedure was for bulk bags (‘fadges’) to be filled by hand for a 300 kg load from the 25 kg bags stored in the shipping containers. The bulk bags were then lifted onto the heli-deck by the ship’s crane, and each time the helicopter pilot landed the bait bucket for refilling, the bulk bag would be moved around by the crane to over the bucket, guided by two loading operators, and the bag emptied rapidly into the bucket. This system proved efficient and safe, and was continued for all subsequent baiting operations. The Aquila also had floodable holds, which when filled with seawater created a greater stability for helicopter operations, significantly reducing the rolling motion on the flight deck.

The second application of bait on 19 July used the same application prescription, of 10 kg/ha out of the bucket with 50% overlap, creating 20 kg/ha on the ground. This was a higher rate than originally planned because crab densities were higher than expected. An extra swath was applied around the lagoon margin, to take account of the high crab densities reported there by the field team. A total of 1250 kg of bait was used for the aerial operation (25.3 kg/ha average). This was applied in less than 2 hours.

On 20 July an additional 50 kg of bait was hand-spread as a precaution in a <0.5 ha area - 5-6 live rats had been seen here the previous night (in contrast to most other areas of the island where rats were either dead or obviously dying). Old bait from the first drop appeared to be scarce or absent in this area and *Coenobita* crabs common.

Due to the small size of the island only one helicopter was used to apply bait on Birnie. Overall, during the two bait applications 2525 kg of bait was applied on Birnie, at an overall average rate of 51 kg/ha total.

Enderbury

The first baiting on Enderbury took place on 15 July and the second on 20-21 July.

It was noted that nearly all species of plants on the island were flowering and/or fruiting and providing an abundant source of food for rats. This appears to have been in relation to recent drought-breaking rains, which created a flush of new growth. While not ideal in terms of targeting the rats, it could not have been reliably predicted or planned for.

Good anchorage was found for the Aquila, and this assisted in creating a very stable heli-deck. Baiting for the first application was concluded within a single day, with 13,300 kg being applied in 44 loads over the treatment area of 608 ha. The island size was slightly larger than anticipated, but this was easily accommodated by drawing upon the contingency quantities of bait. The bait

was applied at a rate of 10 kg/ha from the bucket, with 50% overlap in swaths (flight lines 40m apart), resulting in an 'on-ground' rate of 20 kg/ha in inland areas, with an extra swath around the coastline. The overall average bait rate for the first application was 21.8 kg/ha.

The numerous small motu in the internal (hypersaline) lagoon were treated as part of the standard flight lines across the island, but were given an extra application of bait using the bait bucket with spinner motor running on idle only, to more accurately ensure bait landed on the smaller motu. Ground-truthing occurred on some motu in order to confirm that sufficient bait had reached them. No gaps or issues were noted.

A problem with one helicopter (a chip plug light indicating engine issues) meant it was withdrawn from the operation partway through the first application, and the baiting was concluded for this and subsequent baitings using the other helicopter. Some mechanical issues also occurred with a bait bucket agitator motor but this was promptly rectified.

The on-island field team reported a large number of dead and dying rats on the evening of the 20th (only the 5th night after the 1st bait application), but still a reasonable number of active rats were observed.

The second bait application occurred in two part days. Only 8 loads were applied on the afternoon of the 20th, with a Tracmap GPS fault in the baiting helicopter having to be traced and rectified, which proved a time-consuming but eventually successful task. The baiting was concluded the following morning with an additional 26 loads. Overall, 10,075 kg was applied, with a nominal 13 kg/ha rate on the ground for all inland areas (bucket flow rate of c. 10 kg/ha, with overlap of 25%, i.e. flight lines 60 m apart). A coastal swath was applied as per normal practice, and extra baiting runs (using c.1300 kg of bait) were conducted to use the remaining bait over areas of suspected or known high-density crab areas, such as the coconut palms and forested areas, as well as for an extra precaution on the motu in the lagoon. The bait application rate on the second application was increased to well above that which was originally planned in order to take into account the high levels of flowering and fruiting of plant species and to use up the contingency bait.

Over both applications, a total of 23,375 kg of bait was used on Enderbury, an overall average of 38.4 kg/ha. Bait flow rates of 10 kg/ha were achieved on both Enderbury and Birnie using a 100 mm aperture disk in the bait bucket, and flying at 40-43 knots. Rates of baiting ranged from c. 1.5-2 tonnes per hour of flying.

Bird-strike was an issue on Enderbury, with a juvenile red-foot booby being found dead after an obvious rotor-strike. On other occasions near-misses were reported with this species, but despite the number of birds of various species, especially on Enderbury, it was not considered by the pilots to be a major issue – they considered that if they maintained an operational speed of less than 50 knots, the birds could almost always recognize the 'threat' and could take effective evasive action.

3. BIOTA OF ENDERBURY AND BIRNIE

3.1 Enderbury

Our surveys built on previous work at Enderbury and spanned vegetation lists, vegetation

mapping (supported by aerial photographs and ground work), bird counts (day and night observations and evening fly-ons) and lizard surveys.

Vegetation

The flora is the most diverse of the four islands that have been targeted for pest removal at the PIPA to date with dominant species being:

- *Boerhavia albiflora* – widespread throughout
- *Portulaca* aff *Lutea* – widespread and often in association with *Boerhavia*
- *Tribulus cistoides* – localized but luxuriant stands in southern part of island
- *Sesuvium portulacastrum* – extensive stands lagoon-side and beyond
- *Ipomoea macrantha* – a narrow band between *Sesuvium* and *Portulaca-Boerhavia* areas
- *Lepturus repens* and *L. pilgerianus* – discontinuous but widespread throughout the island
- stands of the trees *Tournefortia argentea*, *Cordia subcordata* and *Scaevola sericea*

Other species included *Triumfetta procumbens*, *Cassytha filiformis* and *Laportea ruderalis*. There are 14 coconut trees mainly scattered along the western shore and 3 inland. A notable feature was that nearly all species of plant on the island were flowering and/or fruiting (report in prep) and flowers and fruits were the focus of rat feeding at least on our first night ashore. Photopoints were established in representative habitats. Maps are currently being prepared of the vegetation zones.

Birds

Bird species and abundance was fairly consistent with our other recent surveys with key features being:

- large breeding colonies of lesser and greater frigatebirds
- important breeding colonies of boobies of three species
- large numbers of breeding red-tailed tropicbirds
- large colonies of sooty terns
- colonies of grey-backed terns and brown noddies restricted to the mainly rat-free lagoon islets
- black noddies and red-footed boobies nesting in *Cordia* and *Tournefortia* stands
- blue noddies confined to roofs of structures, but also one pair prospecting in coral debris at the lagoon-edge
- three species of shearwater prospecting
- no bristle-thighed curlews present.

Based on these observations and others since 2000, the following changes can be expected if the rat eradication succeeds:

- the prospecting shearwaters and blue noddies will nest and achieve a high breeding success with subsequent increase in numbers. The blue noddies are likely to demonstrate the fastest growth given that they mature at a younger age than shearwaters do and they are also likely to recruit birds from neighboring Rawaki.
- the grey-backed terns and brown noddies will also begin to breed successfully beyond the confines of the lagoon islets.
- the Enderbury colonies could become very large in the near future.

- Phoenix petrels and white-throated storm petrels have been observed here in the recent past and should also recover in the medium term. If they do not respond in the medium term then the feasibility of using vocalized lures and translocation should be considered.



Fig 3.1 – Landing biota team at Birnie



Fig 3.2 – Islets in the lagoon have provided the only rat-free environment on Enderbury



Fig 3.3 – Blue noddies, the most primitive of the terns, here roosting on the only rat-free structure at Enderbury – rats have prevented their recolonisation of Enderbury and Birnie.

Reptiles and crabs

Snake-eyed skinks, mourning geckos and Asian house geckos were found on Enderbury, the skinks being in particularly high numbers (report in prep). Turtle nests were observed along sandy parts of the west coast. Hermit crab (*Coenobita perulatus*) densities were at particularly low levels c.100 times less than previously measured¹ (report in prep).

3.2 Birnie

Previous visits have failed to gather significant baseline data other than fly-on bird counts, but we were able to add significantly to this in 2011. This additional work included flora descriptions, bird breeding data and lizard surveys:

Vegetation description

The flora appears to be restricted to the following species – widespread *Boerhavia albiflora* and *Portulaca*, aff *Lutea*, *Sesuvium* which flanks the lagoon, a pocket of *Sida fallax* south of the lagoon, isolated stands of the grass *Lepturus repens*, and an apparently dead *Tournefortia* near the lagoon. Several vegetation photopoints were set up in representative habitats and using local topographical features for orientation.

Birds

Day and night colony counts and seabird fly-ons were completed. Compared with Enderbury, species richness and numbers were relatively low, consistent with previous observations during fly-on surveys. As recorded before, some rat-sensitive species were

present in moderate numbers, including grey-backed terns, sooty terns and brown noddies. Some additional sensitive species have been seen flying on in the recent past including blue noddies and Audubon's shearwaters. Only two bristle-thighed curlews were present during the two baiting days.

Lizards and crabs

Surveys completed by Stacie Hathaway failed to locate any lizards on Birnie. Hermit crabs were patchy and locally abundant, particularly near the lagoon and in vegetated areas near the shoreline (report in prep).



Fig 3.4 – rats have prevented most seabird species from recolonising Birnie.

Biota responses

If the rat eradication succeeds the responses of seabirds at Birnie can be expected to be similar to that at Enderbury, e.g. rapid responses in tern and noddy numbers and productivity. Some species, e.g. wedge-tailed shearwaters, will have difficulty burrowing into the coarse substrate. Petrels and storm-petrels are likely to recolonise, but this needs to be monitored. Vegetation and lizards also need to be monitored to determine their responses (if any from lizards).

4 PEST-FREE RAWAKI,

Rawaki is the only island in the Phoenix Group that has not been invaded by rats and as a result it has outstanding seabird values. It did however support rabbits for over 100 years

before these were removed in May-June 2008. A subsequent visit in November 2009 confirmed the pest-free status of Rawaki and revealed positive responses from some plant and seabird species within 18 months of rabbit removal⁵. In July 2011 we visited Rawaki briefly to further gauge the biota response through repeating vegetation photopoints, counting birds at day, night and during evening fly-ons, and undertaking searches for lizards.

Key observations were:

- a continuation in the spread of *Sida* stands around the island
- a corresponding occupation of *Sida* bushes by lesser frigatebirds
- a continuation in the spread of blue noddies into better vegetated parts of the island
- continued use of the island by endangered species – Phoenix petrel and white-throated storm petrel
- the spread of Audubon’s and Christmas shearwaters into areas that had previously been favored by rabbits (in lagoon-edge *Lepturus*, *Portulaca*, etc)
- no lizards were found on the island.



Fig 4.1 – Derek returning to a rejuvenated “desert” on Rawaki 3 years after he removed the last rabbit.



Fig 4.2 – Andrew negotiating around the sooty tern nests - 17 species of seabirds nest on Rawaki with about 1 pair per square metre.



Fig 4.3 – Rawaki is the PIPA stronghold for the Endangered white-throated storm –petrel

5. KANTON AND MANRA SURVEYS

5.1 Kanton

Kanton offers significant opportunities for seabird recovery⁵ and also has considerable ecotourism potential. A key issue for restoration however lies in improving the biosecurity of the seaport (and future airport) to ensure that the future gains made from any pest eradications (cats and two species of rat) are secured well into the future. During our 2011 visit we discussed biosecurity and pest eradications with the locals and assessed local logistics for potential eradications. Key observations were:

- seabird colonies in Channel Island and Spam Islands as in 2009, boobies on S Peninsula, but no sightings of Phoenix petrels there from Aquila in late afternoon
- locals confirm the presence of cats at village area only
- locals confirm the two rat species (*Rattus rattus* and *R exulans*) are widespread – trapped either side of lagoon entrance in 2009
- locals are keen to trap rats at Port for domestic and biosecurity purposes and 10 traps were left with Daveti
- favorable logistics for undertaking pest eradications.



Fig 5.1 – Ray, Daveti and other locals discussing port biosecurity issues at Kanton

5.2 Manra

Manra was surveyed during two days and a night. Separate parties completed in total a circuit of the outer island, surveys of the lagoon edge, plantation and samples of the indigenous vegetation. The coconut plantation area of the western corner of the island (former village area) is succeeded by indigenous forest which is more diverse than that of the northern five islands and includes healthy stands of *Guettarda*, *Morinda*, *Scaevola* and *Cordia*. Key observations regarding fauna were:

- the vegetation is little changed from Stoddart's original descriptions
- small numbers of feral cats and large numbers of black rats occur in the plantation part of the island at least
- cats may be restricted by the scarcity of fresh water on the island although this could change in a wet year
- Pacific rats have also been reported on Manra in the past and may be present in the more distant and indigenous habitats
- c.20 rat-free and cat-free islets in the central supersaline lagoon support successfully nesting colonies of sooty tern, grey-backed tern and brown noddy
- ground-nesting birds on the mainland are restricted to masked boobies and red-tailed tropicbirds, but predator removal would see many positive responses and provide opportunities for reintroduction of forest vertebrate species
- tree-nesting birds are the red-footed booby, black noddy and white-tailed tropicbird, the latter also found at Nikumaroro but nowhere else in PIPA
- presence of mourning gecko, oceanic gecko and snake-eyed skink.

The island also contains considerable human history dating from Polynesian days through guano collection (well-preserved railway embankments, guano test holes etc) and subsequent copra production (water tank), crashed plane from World War II, etc.



Fig 5.2 – aerial view of rat-free islets in the lagoon and 19th century railway embankment.



Fig 5.3 – Katareti and former railway route



Fig 5.4 – Andrew and Graham examining WWII plane wreckage in coconut plantation.

6. DISCUSSION AND RECOMMENDATIONS

The 2011 operations on Enderbury and Birnie went efficiently and smoothly and they need to be followed up in 2012 (preferably) or 2013 to determine their success, along with the responses of biota. This should ideally be combined with a visit to McKean to determine ongoing biota responses, and if possible also include Rawaki at that time.

If the operations on Enderbury and Birnie are successful then they will represent a future cost-effective approach for eradicating pests in the remaining PIPA islands and elsewhere in the central Pacific. The cost per hectare of this operation using helicopters from a boat was about half the cost of the ground operations undertaken at Rawaki and McKean in 2008 (\$1300/ha, c.f. \$2500/ha). This cost would of course come down per unit area if more islands and larger islands are treated. There are other advantages conferred by the aerial application approach too, particularly a greater reliability of coverage and high operator safety levels, e.g. the 2008 operations required multiple landings through unpredictable surf conditions and more physical handling of bait.

What next for the PIPA?

The first step is the reporting process including debriefing the PIPA Management Committee and discussing the way forward. Pending those discussions, a potential approach could involve four steps:

1. **Secure our gains**, i.e. implement and maintain a higher level of biosecurity in the PIPA. This is being addressed for domestic vessels (at Betio and Kiritimati Ports) but needs improving at Kanton (current policeman plans at least to trap rats at the Port but this needs supporting with a permanent or rotated biosecurity staff position); observers on tourist and research vessels; and plans are in place to achieve the same with foreign fisheries vessels via training of Kiribati observers⁷.
2. **Measure the benefits of 2-4 restored islands and address any island issues**, i.e. determine responses of biota (especially vegetation, birds, reptiles), address any threats that might emerge (e.g. weeds), assess any further management e.g. lures, translocations.
3. **Plan for invasive eradications on Manra, Orona, Nkumaroro, Kanton**. This would be most cost-effective as a single rat baiting operation spanning all four islands, followed by removal of any surviving cats. The cost of cat eradication is probably less than previously estimated, at least on Kanton and Manra, because of apparently restricted cat distribution on those islands than on Orona⁵.
4. **Consider special situations, e.g. Manra and Enderbury coconut trees** – should Manra trees be controlled to confine them to their current distribution (the removal of black rats could facilitate expansion of coconuts on the island)? Meanwhile the removal of the 14 coconut trees at Enderbury may lessen the chances of illegal landings there. It is five years since Nkumaroro was surveyed and no cats were

found there at that time¹ – it would be straight-forward for a Kiribati representative of the next voyage there to check for cat sign. Consider also future reintroductions of representatives of lost fauna and flora – should involve study of subfossil fauna.

Time frames for these four activities are not mutually exclusive, but clearly enhancing the biosecurity of the PIPA is an urgent priority. Effective quarantine at Kanton in particular is a prerequisite for the proposed pest eradications there – there is no point removing rats from Kanton if there is a high reinvasion risk via the seaport. This should be discussed and action agreed at the next PIPAMC debrief.

ACKNOWLEDGEMENTS

Planning for and execution of the Enderbury-Birnie operation was funded by the Packard Foundation, CI/CEPF and we particularly thank our contacts there – especially Bernd Cordes (Packard), John Watkin, James Atherton, Sue Taei, Michael Donoghue, Greg Stone (all CI), Greg Sherley (UNEP), Regen Jamieson (NEAq) and Graham Wragg (Pacific Expeditions). The Government of Kiribati provided administrative support and we particularly thank Tukabu Teroroko and Ratita Bebe for coordinating permit effort. Field support was expertly provided by Captain Kale Garcia and the crew of the MV Aquila, staff of HeliOtago (Peter Garden and David Gale), Pathfinder (Dave Sanderson), together with Stacie Hathaway (USGS), Andrew McDonald, Katareti Taabu and Nick Torr. The collaboration with Palmyra (Island Conservation and Henderson (RSPB)) proved very worthwhile and we thank colleagues there, particularly Alex Wegmann, Richard Griffiths, Jonathan Hall and Clare Stringer. Staff of NZ Department of Conservation provided their usual high standard of advice throughout.

REFERENCES

- (1) Pierce R.J., T. Etei, V. Kerr, E. Saul, A. Teatata, M. Thorsen, G. Wragg. June 2006: Phoenix Islands Conservation Survey April-May 2006: a feasibility study for the ecological restoration of the Phoenix Islands, Kiribati. *Eco Oceania Ltd* Contract Report for Conservation International, Samoa, and the Invasive Species Specialist Group c/- Auckland University, Auckland.
- (2) Thorsen, M. Pierce, R. Broome, K. 2008. Operational plan for the eradication of three exotic mammal species from three islands in the Phoenix Group, Kiribati. Unpublished report, *Eco Oceania Ltd*.
- (3) Taei (ed) 2010. PIPA Management Plan.
- (4) Pierce R., Nautonga Anterea, Uriam Anterea, Keith Broome, Derek Brown, Lance Cooper, Hannah Edmonds, Fran Muckle, Bill Nagle, Grant Oakes, Mike Thorsen, Graham Wragg. 2008. Operational work undertaken to eradicate rats and rabbits in the Phoenix Islands, Kiribati, May-June 2008. Pacific Expeditions Ltd report for Government of Kiribati, NZ Department of Conservation, NZAID and Pacific Invasives Initiative. October 2008
- (5) Ray Pierce, Nautonga Anterea, Glen Coulston, Clea Gardiner, Louise Shilton, Katareti Taabu, Graham Wragg 2010. Atoll restoration in the Phoenix Islands, Kiribati:

survey results in November-December 2010. EcoOceania Pty Ltd and Pacific Expeditions Ltd report for Government of Kiribati, Critical Ecosystem Partnership Fund, NZ Department of Conservation, NZAID and Pacific Invasives Initiative.

(6) Brown, D 2011. Operational Plan for the Eradication of Pacific rat *Rattus exulans* from Enderbury and Birnie Islands in the Phoenix Group, Kiribati.

(7) Eco Oceania Pty Ltd 2011. Biosecurity Guidelines for the Phoenix Islands, Kiribati. Report for Critical Ecosystem Partnership Fund and Government of Kiribati.

(8) Eco Oceania Pty Ltd 2011. Opportunities to restore the terrestrial ecosystems in the Phoenix Islands, Kiribati, by removing invasive alien species

(9) PIPA 2010b. Phoenix Islands Protected Area, Kiribati: Nomination for a World Heritage site. Draft report.

(10) Pierce R, Brown D. 2009. Technical support and capacity building for the Wildlife Conservation Unit and Quarantine at Kiritimati, Kiribati, May-June 2009. EcoOceania Pty Ltd Report for Government of Kiribati, NZ Department of Conservation, Pacific Invasives Initiative and NZ AID, August 2009.

Appendix 1 - Field timetable July 2011 (Samoa time):

5-7	Participants travel to Apia, Samoa from Australia, Kiribati, New Zealand, Cook Islands, while MV Aquila reaches Apia; meetings/dinner with CI staff
8	Aquila arrives, customs, immigration; unloading; re-packing, stowing of bait
9-10	Purchase of stores, final preparations, etc
11	Final purchases, clear Customs, depart Apia 1230 h, seabird transects pm.
12	Aquila traveling N opposite Tokelau, seabird transects
13	Aquila traveling N to PIPA, baiting prep, biosecurity checks, seabird transects
14	Arrive Birnie, biota party ashore, baiting afternoon, overnight to Enderbury
15	Arrive Enderbury am, biota party ashore overnight, baiting begins
16	Complete baiting and biota checks, travel to Kanton overnight
17	Kanton meetings survey, depart for Rawaki overnight
18	Arrive and land at Rawaki am, biota survey overnight
19	Depart Rawaki for Birnie, 2 nd baiting of Birnie pm, biota party ashore overnight
20	Depart Birnie for Enderbury, 2 nd Enderbury baiting; biota party ashore overnight
21	Complete 2 nd baiting at Enderbury; collect shore party; overnight travel to Manra
22	Land at Manra and complete overnight surveys of biota and pests
23	Complete Manra survey; depart overnight for Apia
24-25	Aquila traveling south to Apia, seabird transects
26	Arrive Apia
27-29	Loading bait etc for Henderson, meetings, debriefs, team members depart