

Enhancing biosecurity at the Phoenix Islands Protected Area (PIPA), Kiribati

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Abstract The Phoenix Islands Protected Area (PIPA) of the Republic of Kiribati was established in 2006 and extended to cover 408,250 km² in 2008. The draft PIPA Management Plan aims to eradicate invasive alien biota (mainly vertebrates) from the top priority islands first then work towards eradication of invasive vertebrates from all eight atolls. Implementing improved biosecurity is crucial across the entire. Key risks identified via workshops and targeted consultation include potential invasions after visits by legal and illegal fishing vessels, tourist vessels and national freighters, any of which can carry a variety of invasive species. Key biosecurity approaches being implemented include passing a National Biosecurity Act, setting up a biosecurity committee, strengthened internal biosecurity as well as at the borders, and emergency response plans. A novel border approach involves the licensed international fishing vessels that visit Kiribati waters, where existing Government of Kiribati on-board observers can be trained in biosecurity and vessels fitted with geo-fencing radio-beacons. We propose that these vessels are required to be pest-free as part of licensing agreements. Surveillance and apprehension of other vessels will be through the complying captains reporting illegal vessels, together with the periodic deployment of aerial and sea surveillance craft. National freighters and other vessels will be inspected at ports of departure where biosecurity is also being strengthened, and also prior to entry at Kanton, PIPA. There is a need for further capacity development as well as international agreements with relevant countries at their departure ports. Our recommended biosecurity approaches are largely untested for Kiribati but will be continually refined.

Keywords: Invasives, surveillance, rats, cats, pigs, rabbits, McKean Island, Rawaki Island

INTRODUCTION

The Phoenix Islands of Kiribati in the central Pacific Ocean are isolated from other island groups in Kiribati by c.1000 km of ocean. The Phoenix Islands Protected Area (PIPA) was gazetted in 2006 and extended in 2008 to 408 250 km², which at that time was the world's largest marine protected area. The eight atolls have received little human settlement, and only Kanton is now inhabited. The plant communities on most of the atolls are little modified. The breeding seabird populations are globally important and comprise petrels and shearwaters (five species), storm-petrel (one species), tropicbirds (two species), boobies, (three species), frigatebirds (two species), noddies (three species) and terns (three species). The resident fauna includes two species of threatened seabirds: the Phoenix petrel (*Pterodroma alba*) and the white-throated storm-petrel (*Nesofregatta fuliginosa*), which are currently IUCN-listed as Endangered and Vulnerable respectively. The islands also provide important habitat for migrant species such as the bristle-thighed curlew (*Numenius tahitiensis*) (Vulnerable), Pacific golden plover (*Pluvialis fulva*) and other shorebirds. Islands in the PIPA are also important breeding grounds for green turtles (*Chelonia mydas*) (Endangered) and support many species of lizards and invertebrates, including the coconut crab (*Birgus latro*), and other species of land crabs.

The biota of the PIPA has, however, been depleted by the impacts of invasive species, particularly mammals comprising ship rats (*Rattus rattus*) Asian rats (*R. tanezumi*) and Pacific rats (*R. exulans*), cats (*Felis catus*), pigs (*Sus scrofa*) and European rabbits (*Oryctolagus cuniculus*). A Critical Ecosystem Partnership Fund survey in 2006 indicated that seven of the eight atolls had been invaded by rats; only Rawaki has remained rat-free, enabling populations of Phoenix petrels, storm-petrels, shearwaters, blue noddies and others to maintain a foothold. However, Rawaki has supported rabbits for over 100 years where they have had serious impacts on vegetation and competed with petrels, shearwaters, storm-petrels and blue noddies for what little nesting cover remained. Meanwhile, large rats have arrived on at least two islands in recent years: Asian rats via a shipwreck on McKean in about 2001 and ship rats by unknown means and at an unknown date at Kanton (Pierce *et al.* 2006, 2010).

In this paper, we review the effects of mammal eradications in the Phoenix Islands to date, outline the biosecurity issues that threaten these and other proposed activities, and indicate how these issues are being resolved.

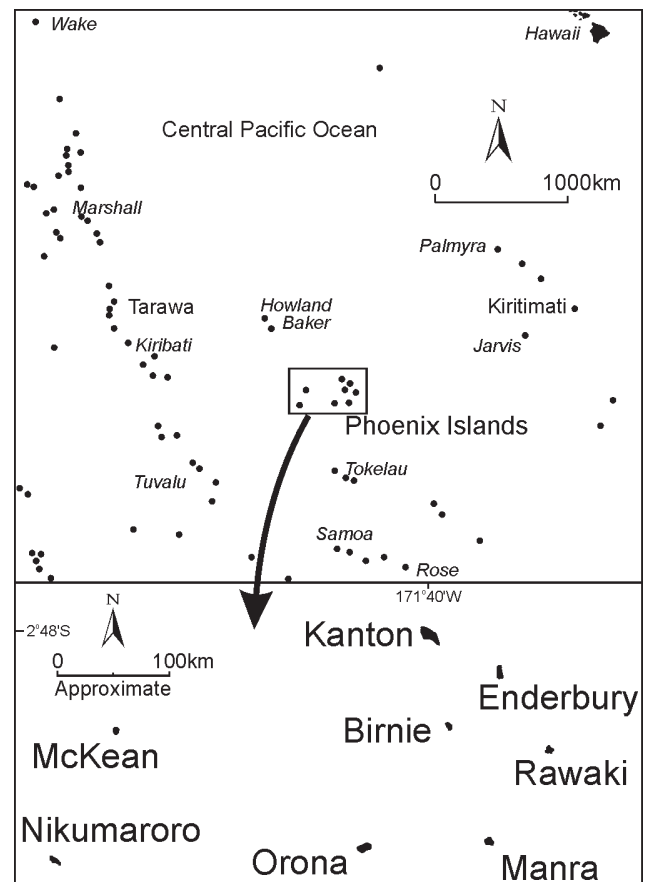


Fig. 1 The Phoenix Islands Group.

Table 1 Pest mammal status in the PIPA 2009.

Island	Approx. area (ha)	Pest status 2009	Comments
Rawaki	50	Nil	Rabbits eradicated 2008
McKean	30	Nil	Asian rats eradicated 2008
Birnie	50	Pacific rat	Operational planning underway
Enderbury	600	Pacific rat	Operational planning underway
Kanton	1100	Cat, Pacific rat, ship rat	Operational planning underway; inhabited island, major biosecurity issues, phoenix petrel etc colonies;
Orona	600	Cat, Pacific rat	Crab issues
Nikumaroro	500	Pacific rat	Crab issues
Manra	400	Cat, rat sp?	Crab issues, needs survey - pigs reported as well

PIPA RESTORATION TO DATE

The PIPA Management Plan (Government of Kiribati 2010a) identified atoll restoration via pest removal and biosecurity as a key objective. A first step towards this objective was achieved in 2008, when European rabbits and Asian rats were eradicated from Rawaki and McKean Islands respectively as part of a project funded and supported by NZAID and NZ Department of Conservation (NZDOC). Positive responses to these successful eradications were apparent 18 months later through changes in vegetation diversity and extent, and seabird productivity at both islands. For example, on Rawaki the shrubs kaura (*Sida fallax*) and *Portulaca*, which are now free of grazing pressure, are regenerating across the island despite a prolonged dry period. These shrubs provide greatly increased nest site availability and cover for frigatebirds, blue noddies, storm-petrels, petrels and shearwaters. On McKean Island, the nesting success of seabirds has increased significantly, notably amongst grey-backed terns and brown noddies, which had previously been losing virtually 100% of their eggs or chicks (Pierce *et al.* 2010). As well as providing local benefits for the PIPA,

the recovering seabird populations will enable several species to potentially colonise other restored island groups in the central Pacific, either via natural dispersal or through artificial translocations.

Planning is currently underway to eradicate pests and restore additional islands, including Enderbury, Kanton and Birnie (Table 1). In addition, there is a crucial need to step up biosecurity measures at the PIPA and beyond to sustain the success of island restoration work. Seven of the islands are uninhabited and there are significant biosecurity issues that could lead to invasive species accessing the islands.

BIOSECURITY ISSUES FOR PIPA

Biosecurity issues in PIPA are similar to those elsewhere in the Pacific, but there are also significant differences and unusual risks. Particular risks are posed by uninhabited islands that are seldom visited by official parties, but which are in the vicinity of considerable risky boating traffic. Foreign specialists and staff of the Ministry of Environment, Lands and Agricultural Development (MELAD) have identified sources and mechanisms of

Table 2 Pest risk analyses and actions needed at pre-border and at-border sites.

Very High Risk				
Pathway	Source	Main risks	Prevention measures & other actions needed*	Responsibility
Illegal landings from people on Kiribati cargo boats that pass through the PIPA, and potential ship-wrecks of the same vessels	Tarawa,	Rats (several spp), mice, cats, dog, birds, ants, lizards	Government observer to be present on these boats to ensure non-landing compliance	PIPA/MELAD
	Kiritimati, and other northern Line Islands		Provide bait stations, rodenticide and rat traps for permanent use by all captains*	Agriculture
	Cargo vessels are		Inspect boats pre departure and on arrival at each of Betio (Tarawa), Kanton and Kiritimati and provide certification or quarantine as appropriate*	Agriculture
	MV Matangare, Moomi, Mataburo, Betiraoi, Moamoa		Reinstate Quarantine/Biosecurity Committee to coordinate above measures and implement new regulations plus risk analysis under new Biosecurity Act. Improve boat hygiene to prevent accidental introduction of pests and monitor permitted/prohibited goods. Improve cargo regulations (prohibited/permitted product lists), cover packing materials and standards for fresh produce (e.g., fruit and vegetables). Regulations for male cats and dogs and restricted to inhabited islands of Lines and Phoenix.	MELAD/PIPA
			Port surveillance and control - currently focused on agricultural pests. Needs improving and broadening to cover rats, ants, cats. *	Agriculture
			Need inter-island regulations to be included under planned Biosecurity/Quarantine Act.	MELAD
			Decide who is responsible for drawing up regulations.	PIPA
			No landing signage	PIPA
			Remove Enderbury coconut trees	PIPA

Table 2 continued

High Risk				
Pathway	Source	Main risks	Prevention measures & other actions needed*	Responsibility
Legal fish boats (illegal landings, wrecks)	US mainland Korea, Taiwan Japan EU (Spain) Ecuador (Spain boats) NZ, China Am Samoa, Betio & Kiritimati offloading Pacific Is transit ports	Rats, mice, cats, ants, birds, reptiles (snakes)	International agreements for boat hygiene - none exists? Inspection at home ports by home country quarantine services? Inspection by Kiribati/observers - aim is 100% of vessels* Kiribati regulations - need developing to cover pests on board, powers of inspectors. Education & awareness in fisheries. Probably needs doing in home countries. Identify ports used. Then above measures apply.	International Agencies International Agencies Fisheries & PIPA Fisheries Act. MELAD (& PIPA). MELAD, Agencies Fisheries & PIPA
Illegal fish boats (illegal landings, wrecks)	IUU and others	Rats, mice, cats, ants	Observers on legal boats report these. Patrol boat and aircraft (Aust/NZ Orion). Get additional boat based in Kanton.	Fisheries GoK Maritime Command PIPA, CEPF.
Passenger/cargo & other planes (e.g., medical, surveillance) to Kanton	Australia, Hawaii, Kiritimati, Nadi, Tahiti	Rats, mice, snakes, lizards, mosquitoes, ants and other insects, frogs, toads, weeds	Form Tech Committee for Risk analysis. Include specific pests, permitted/prohibited product lists, packing standards, standards for fresh produce (e.g., fruit and vegetables), domestic animals, on-board treatments (e.g., residual insecticides). Draft pre-border agreements (different for each source country?) and seek pre-border agreement approval. Draw up regulations for airlines under planned Biosecurity Act. Implement regulations. Design improved quarantine procedures (including surveillance at airports for selected range of pests) and incorporate into regulations under planned Quarantine Act. Establish/improve quarantine (procedures including surveillance, facilities, officers) at Kanton & Kiritimati airports (and other airports in Kiribati).	Agriculture, SPC, SPREP, PIPA; ECD; outside input to risk analysis Agriculture (Quarantine), SPC, SPREP, PIPA; ECD. Agriculture; input from ECD, PIPA, SPREP, SPC. Ag - Quarantine Input needed from PIPA Committee, ECD, SPREP, SPC. Ag (Quarantine)
Moderate Risk				
Pathway	Source	Main risks	Prevention measures & other actions needed*	Responsibility
PIPA Patrol boat	Tarawa, Kiritimati, Penrhyn	Rats, mice, ants	Maintain rodent bait station, inspect boat on departure (Tarawa, Kiritimati) and arrival (Kanton)*	Agriculture
Yachts (legal & illegal landings, wrecks) - < 50 applications per year.	Tahiti, Marquesas, Cooks Hawaii Kiritimati	rats, mice, birds, dogs, cats, lizards, ants, weeds	Review and possibly improve permit conditions. Improve inspection (procedures and training) in entry ports. Implement inspections in ports of entry (Kiritimati, Tarawa, Kanton, Fanning)	PIPA, ECD, SPREP. Ag (Quarantine). Ag (Quarantine).
Live-aboard tour boats (legal landings, wrecks)	Cooks Fiji	rats, mice, ants, geckos, insects, weeds	Update permit guidelines* Implement guidelines on permit. Inspections - observers on boats*	EcoOceania, SPREP, SPC. Currently rely on Captains. PIPA, Fisheries
Research & management boats (Naia, etc) (legal landings, wrecks)	Hawaii Samoa - Rarotonga	Rodents, snakes, lizards, mosquitoes, other insects, frogs, ants, weeds	Provide permit guidelines Update permit guidelines* Implement guidelines on permit. Inspections – observers on boats*	PIPA Technical input required as above. Currently rely on Captains. PIPA, Fisheries.

Abbreviations – Ag Agriculture division, ECD Environment and Conservation Division, MELAD Ministry of Environment, Lands and Agriculture Development, PIPA Phoenix Islands Protected Area, EU European Union, IUU Illegal, Unregulated and Unreported fishing vessels, CEPF Critical Ecosystem Partnership Fund, SPC Secretariat for the Pacific Community, SPREP Secretariat for the Pacific Regional Environment Programme,

* indicates details of recommended work being prepared in the Guidelines document.

potential pest invasions in the PIPA. This risk assessment was undertaken through workshops and meetings at Tarawa and included members of the PIPA management Committee, South Pacific Regional Environment Programme (SPREP), Secretariat for the Pacific Community (SPC) and ourselves, followed by subsequent discussion with key contacts.

Highest risks include, but are not limited to, rodents, cats, ants, other invertebrates, and seeds, being present on vessels and potentially invading PIPA islands via the following pathways: 1) passengers making illegal landings from domestic cargo ships; 2) personnel making illegal landings from fishing vessels; 3) researchers, managers and tourist operators making legal landings from vessels; 4) cargo off-loaded at Kanton or taken aboard at Kanton; 5) shipwrecks/groundings of yachts, fishing boats, cargo ships; and 6) air cargo arriving at Kanton in the future.

Recent steps to improve biosecurity include initiatives internally and at borders:

1) Kiribati Biosecurity Act, imminent (Government of Kiribati 2010b); 2) PIPA biosecurity guidelines being developed via CEPF funding; 3) Kiribati domestic freighters fitted with rodent bait stations and captains provided with bait; 4) monitoring by Agriculture staff at embarkation and destination ports; 5) a PIPA geo-fence in which legal fishing vessels are fitted with a radio beacon for satellite monitoring of locations and monitored from the Police Maritime Unit at Betio, Tarawa; 6) trained Kiribati fisheries observers on board these legal vessels; 6) banning PIPA island landings to all but essential work; and 7) legal visitors to comply with landing protocols, with permits, and have PIPA staff present.

BIOSECURITY GUIDELINES

Summary of risks and needs

Biosecurity guidelines under development include comprehensive quarantine, surveillance, and response measures based on the risk assessments and summarized in Table 2. The level of risk in the Table (very high, high, and moderate) refers to the perceived likelihood of an invasion. No differentiation is made between impacts of different invasive species as they are all impacting and full implications are still unknown for some, e.g., different ant species.

The biosecurity guidelines being developed will provide a series of prescriptive tasks and data sheets that are intended to help guide the people responsible for the biosecurity actions identified in Table 2.

Proposed quarantine tasks

Because the PIPA islands are largely uninhabited and seldom visited, any invasive alien species (IAS) incursions could remain undetected for long periods and become expensive or impossible to eliminate (e.g., in the case of invasive ants). The emphasis therefore needs to be on invasion prevention. The highest priority needs include: 1) effective vessel quarantine together with IAS control at the ports of embarkation and arrival, e.g., Betio (Tarawa), Kiritimati and Kanton as part of the certification process under the pending Biosecurity Act; and 2) building on existing Agriculture Division process, including datasheets and reporting. The most urgent tasks in support of this process are to remove rats from inter-island freighters and this is starting to be implemented by Quarantine staff, initially at Kiritimati, and will be extended to Tarawa (and subsequently Kanton), using combinations of permanent bait stations and traps on the vessels and searching for rodent sign, and having independent verification via Government staff and passengers. Because of limited staff

and potential work bottlenecks, collaborations between Quarantine and Environment divisions of MELAD along with port authority staff are essential in order to achieve effective results and these are being formally established, initially at Kiritimati. Future timetabled needs for freighters include surveillance for other IAS on vessels and at the ports, to include invasive ants, weeds, and birds.

Quarantine of fisheries vessels could be approached in a similar way with certification of pest-free status being verified by trained observers present on the licensed vessels at departure and throughout the fishing voyages. To date, the observers have been trained in a fisheries role only but they will be retrained to include IAS responsibilities. All other visiting vessels, e.g., research and management vessels are required to adhere to biosecurity guidelines as part of the permitting process or have their own approved biosecurity plan in the case of landing parties.

A key need at Kanton is to have quarantine representation on that atoll to ensure local quarantine procedures are strictly followed. This need increases further with future IAS eradications proposed for the atoll and increased ecotourism which might also see the reopening of Kanton Airport.

A recommended timeframe for key quarantine actions is:

2010 - begin rodent control on cargo vessels (Ag, underway)

2011 - begin rodent control in port compounds at Tarawa and Kiritimati (Ag); verify effectiveness of cargo vessel work (Ag and independent)

2011 - train fisheries trainers in biosecurity for them to train observers in rodent surveillance and control, but also awareness of other IAS (Independent/Ag)

2012 - other IAS in port compounds – survey/surveillance, review/refine training of fisheries observers (Ag)

2012/13 - aim for Kanton Quarantine officer by now (MELAD).

Proposed surveillance tasks

Although quarantine is the key need, surveillance of priority islands is still advisable in order to detect pests before they become fully established and/or impact severely on sensitive biota. This will be addressed via Government observers present on all licensed vessels visiting the PIPA islands whether they are undertaking patrols, research, management or tourism. Guidelines are being developed to monitor sensitive indicator species, e.g., blue noddy (*Procelsterna cerulea*), and search for pest sign including, direct observations, gnaw-marks on eggs and discarded bird bones. These data will be held by the PIPA office.

In the case of the now pest-free islands (Rawaki and McKean), landing is generally discouraged to minimise risks of unforeseen incidents (IAS and accidents) and to set an example for all to follow. The exception would be if the government observers and other technical people present on vessels offshore believe there may be problems ashore. For example, if observers see sign of illegal landings on pest free islands and/or note that the sensitive indicator species are scarce, there is a standardized checklist for each observer to follow (Table 3).

Although the key need is to develop quarantine procedures to prevent incursions, there will always be some risk of pests reinvading. The biosecurity guidelines being developed for the PIPA do include recommended responses to invasions, including the broad approaches in Table 4.

Table 3 Example of a step by step approach for surveillance of pest-free PIPA islands.

Step	Activity	Items needed
1	<p>From offshore, scan the entire foreshore for signs of illegal landings, shipwrecks, and, if it is possible to get in close enough, any sign of cats/rats on the upper beaches.</p> <p>From the vessel do a fly-on bird count – in evening (5.00 pm to dark) anchor boat at safe site c.100-150 m out from “the landing” and count the small sensitive birds (blue noddy, shearwaters and storm-petrels) flying to shore and within 100 m of your boat, i.e. a 200 m wide swath.</p> <p>If bird counts are high on Rawaki and nothing suspicious seen, then no further work is required except to complete the survey form. If fly-on counts of blue noddies at Rawaki are < 50 and/or there is sign of landing or other suspicious sign at either island go to step 2</p>	Binoculars, surveillance form, instructions for fly-on counts
2	<p>If you suspect there is a problem on the island and landing conditions are OK, follow biosecurity landing protocols and go ashore to search for invasives and their sign particularly focusing on:</p> <ul style="list-style-type: none"> - tern/noddy colonies - are there any rat-eaten egg-shells or gnaw marks on any bird bones? - are there any ants on eggs or chicks or at the landing sites/structures? <p>If invasive sign is found on eggs or birds photograph and go to step 3 (rodents) or 4 (ants)</p>	Landing permission, landing protocols, safe landing gear, vials with preservative, digital camera, survey form, map of island, detailed methodology
3.	<p>From late afternoon search for rats and other vertebrate predators into the night, and estimate numbers seen and map where they were seen and map where you have been. If rats are more extensively spread and there is not enough bait at hand (5 kg/ha required) to cover the island, do not attempt to poison them. Instead confirm species by catching and collecting several individuals by running them down (easy to do during the day) and weigh and measure and collect specimen as per data sheet. If rats or other IAS are found alert the PIPA office immediately (Tukabu Teroroko ph +686 29762, mobile +686 94571) and provide details as more information may be needed. Tukabu will contact members of Biosecurity Committee for further advice. The boat should remain near island (in case more information is needed) until cleared by PIPA office to leave</p>	Strong headlamps or torches, batteries, ruler or callipers, 300 g Pesola balance, specimen jars and ethanol preservative or freezer. Pestoff bait (brodifacoum) - ideally have 100 kg available on patrol boat.
4.	<p>Other surveillance</p> <p>If invasive ants are found at seabird colonies, determine their distribution on the island by establishing standard ant survey stations</p> <p>If invasive plant species (e.g., lantana, <i>Pluchea</i>) are found, photograph, determine the location of these sites by GPS and mark on a map of the island. If there are few plants, remove all the plants by digging them out taking care to include the entire root system as well as all seeds and place all these in a sealable container for later incineration. Also mark the sites on the ground with coral cairns in order to check for re-growth on later visits.</p> <p>Go to step 5</p>	Ant survey kit containing vials, sugar solution, protein lures, preservative, marking pens, GPS.
5	All surveillance data and reports to be sent to PIPA office for follow-up action and filing	Weed surveillance booklets, camera, spade, containers, map of islands, data sheet, GPS.

Note that Enderbury and Birnie will be added to this island grouping once rats are removed – currently these and all other islands should be checked for signs of illegal landing, wrecks, etc.

Can planned biosecurity implementation work?

Action is urgently being directed towards the most likely pathway (cargo and fishing vessels) that could bring additional invasives to the PIPA and is based on the priority setting of Table 2. These actions include the use of rodent bait stations with brodifacoum, which has a fast kill rate, and rodent kill traps. This will be complemented with rodent control at the departure ports, mainly Betio/Tarawa and Kiritimati, and also at Kanton. When these most urgent procedures are working effectively, as determined by independent audit, vessel surveillance will be extended to incorporate searches for invasive ants, other invertebrates, reptiles, and weed seeds, including addressing IAS control at the port compounds and other nearby sources of IAS.

The success or otherwise of these proposals depends on sustained commitment in key areas including:

Developing trust and effective working relationships amongst government staff and with captains of fishing vessels, freight vessels, tourist vessels, and other vessels

Cooperation of community as passengers on vessels, and visitors to and neighbours of the port compounds

Having capacity and tools to do an effective quarantine job at source ports

All breaches of protocols and related issues are reported for court proceedings

Having the ability to respond effectively to biosecurity issues, e.g., mobilising surveillance aircraft and vessels, including patrol boats, to intercept illegal vessels

Having effective pest surveillance and an ability to respond quickly to any invasives arriving at the PIPA

Table 4 Summary of emergency response needs for the PIPA.

Objective	Tasks and responsibility
Identify biosecurity advisory team	An interim team led by PIPA Director has been identified to provide advice - available by phone if needed (PIPA)
Confirm identity of invading IAS species	Species-specific approaches e.g., for rodents capture by running down, trapping, sticky pads for hair; for specimens photograph, measure head and body length, also tail length, preserve in freezer or preservative; Collect and preserve any ants that appear potentially IAS; Collect weeds in sealed bags; GPS sites; Describe size and coat pattern of cats (PIPA Director/GoK rep)
Consider feasibility of immediate eradication with advisory team	With advisory team's phone advice via PIPA Director, assess whether IAS may be able to be eradicated immediately – e.g., cats by shooting and/or running down in the open; weeds by bagging, GPS site. (PIPA Director/advisory team)
Response procedures known	Broad response procedures for most likely invasives are being developed; include response team, bait etc availability, transport, timing of response and minimising impacts on non-targets (PIPA Director/Response team)
Funding	Emergency funding sources are currently an issue, but will be less so as the PIPA Trust undertakes fundraising (PIPA Director)

Improved quarantine procedures for all international vessels operating in the PIPA

A budget to cover all aspects of equipment, personnel, training, and emergency responses. Some of these costs can be passed on to PIPA users but an ongoing internal budget is required

A Biosecurity Team that includes individuals experienced in managing quarantine, surveillance and response issues

Implementing biosecurity education for targeted groups and the community.

Each of these steps is needed in order to sustain the island restoration gains through pest removal that are currently being made in the PIPA via pest removal. Sustaining this level of biosecurity commitment may at first seem expensive and daunting, especially to Kiribati staff. All of the above needs are ultimately achievable, but biosecurity implementation should begin with high priority needs first, i.e. addressing rodents on cargo vessels as is currently the focus, followed by fishing vessels and ports. Gradually, surveillance and control of the other IAS that can threaten the PIPA should be brought in after this together with increased education. Currently some establishment costs of biosecurity are being met partly by aid projects including CEPF- and NZODA-funded work, but in future the costs of sustaining effective biosecurity needs to be borne by biosecurity users, i.e. revenue generated from the fisheries licenses, freighters and research/tourism expeditions. Much generic IAS material is also widely applicable to the PIPA and Kiribati generally, including technical and education material (e.g., ACP 2010, PII 2010 draft, Tye 2009, Veitch and Clout 2002).

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