GUIDELINES ON

NON-TARGET SPECIES

PURPOSE

- These Guidelines are to be used by Project Managers conducting rodent eradication projects based on the PII Resource Kit for Rodent and Cat Eradication.
- The Guidelines provide information on what to consider when eradicating on islands that also have non-target species present.

1. WHAT ARE NON-TARGET SPECIES?

- A non-target species is any species present on the island that is not the target of the eradication operation.
- Non-target species on Pacific Islands include:
    - Seabirds
    - Domestic animals and livestock
    - Feral livestock
    - Crabs
    - Lizards
    - Bats
    - Invertebrates
    - Other native species

2. WHY MUST WE CONSIDER NON-TARGET SPECIES?

- Non-target species need to be considered in eradication projects because:
    - **Risk to non-target species.**

      Non-target species can be adversely affected by the project. A major risk when using a toxic bait is that non-target species will also be killed by eating the bait. While poisonous to rodents, the common toxins used in eradications are also poisonous to some other species. Which non-target species are at risk from poisoning from the toxic bait will depend on the actual toxin used.

      Secondary poisoning risks also need to be considered. When a non-target species is not harmed by eating the bait, but the toxin accumulates in its body, then any of its predators will be at risk of poisoning. This is known as secondary poisoning.

When using toxic bait, it is possible that some non-target animals may die as a result of the eradication operation – the focus is on ensuring human safety and the survival of species at the population level.

Undertaking an eradication project may also adversely affect non-target species in other ways, for examples many seabirds are significantly disturbed by human activity close to nesting or burrow sites. Such disturbances can cause nesting seabirds to abandon their nests, colony breeding failure and ultimately may endanger the survival of the colony

- **Interference.**

  Non-target species can also pose a risk to the eradication project. Some species eat large amounts of bait meant for the target species, which reduces the amount of bait available to the target species. While other species have been known to damage or block access to bait stations.

  In the Pacific, the impact of some species of land crabs is a major issue.

3. WHAT TO DO

1. Experience with eradication projects in the Pacific and other regions have built up some understanding of the possible non-target species risks. While this knowledge grows with each eradication project there still remain significant gaps in our understanding of non-target issues in the Pacific.
2. The range of potential issues will be unique at each eradication site. Every eradication project must ensure that the Feasibility Study thoroughly assesses the risks to and from all non-target species present. Where required, plans to manage each risk must be implemented.
3. To manage the non-target risks follow the 4 steps:

   1) Identify the non-target species present on the island.

   2) Assess whether the project poses any risks to the non-target species.

   3) Assess whether the non-target species will interfere with the project.

   4) Implement management plans to deal with each of the risks you have identified.

3.1. IDENTIFY THE NON-TARGET SPECIES PRESENT

- During the Feasibility Study create a list of all non-target species present on the island and record it in the Feasibility Study Report.

3.2. ASSESS THE RISKS TO THE NON-TARGET SPECIES

- A common risk on Pacific Islands is the disturbance of nesting seabirds due to the presence of the project team and project activities.
- The likelihood of non-target species eating the toxic bait will be affected by their diet, bait palatability and availability of alternative food sources.
- Use non-toxic bait trials to establish whether non-target species will eat the bait.
- To assess secondary poisoning risks you will need to determine which species predate on any non-target species that eat the bait and the effects of the poison on these predators.

3.3. ASSESS THE INTERFERENCE FROM NON-TARGET SPECIES

- The likelihood of non-target species eating the toxin will be affected by their diet, bait palatability and availability of alternative food sources.
- Use non-toxic bait trials to establish whether non-target species will eat the bait.
- Trial deployments with non-toxic bait should be used to assess how non-target species interfere with the bait stations.
- If non-target species are identified to be eating significant amounts of bait, establishing the densities of the non-target species population will be required to calculate increased bait application rates.

3.4. MANAGE THE RISK

- For each of the risks identified in the preceding sections you will need a plan to manage the risk to an acceptable level.
- The risks and the management plans will be different for each eradication project. Expect to spend time during the Feasibility Study and the Operational Planning Stages trialling different management options to identify which are best suited to the identified risks.
- Toxic baits in the natural environment breakdown over time and lose their toxicity. To manage the risk of the toxic bait you will need to know how long bait takes to breakdown at your eradication site. See the Guidelines on using Broudifacoum.

4. MANAGEMENT OPTIONS

- Some of the actions to consider using to manage non-target species risks include:

4.1. NO TAKE/HARVEST PERIODS

- Used to minimize the risk of secondary poisoning in people.
- If non-target species that eat the bait are also eaten by the local population then a temporary ban on eating the food will reduce the risk of secondary poisoning in the community.
- To be effective, wide spread community support is required.
- An extensive public awareness campaign, including wide stakeholder communication and warning signs at key locations is required.

4.2. TEMPORARY REMOVAL

- Used to prevent non-target species being poisoned by eating the toxic bait.
- The whole or part of a population at risk from poisoning is removed from the island. After the eradication operation, once the bait has degraded and is no longer dangerous the population is returned to the island.
- This technique has been used to safeguard endangered native species and protect domestic and feral livestock.
- For some native species, experts will be required to catch, translocate and care for the animals while in captivity.

4.3 TEMPORARY ENCLOSURE

- Used to prevent non-target species being poisoned by eating the toxic bait.
- Domestic livestock that are usually allowed to roam freely are securely contained within a safe enclosure for the period of danger.
- The effectiveness relies very much on the quality of the enclosure.

4.4. INCREASE BAIT APPLICATION RATES

- Used to mitigate the interference of non-target species eating the bait.
- Increase the bait application rate if non-target species eat significant volumes of bait. This will ensure that even after some has been eaten by non-target species, the required amount of bait is still available to the target species.
- Use non-toxic bait trials to establish how much extra bait to apply.

- The amount of bait eaten at any location will depend on the population density of the non-target species. Measure non-target species population densities so that you can calculate extra bait rates for different locations.

4.5. APPLY REPELLENT

- Used to decrease the amount of bait eaten by non-target species.
- Apply a repellent to the bait that is known to repel the non-target species.
- Ensure the repellent does not repel the target species.
- Ensure the repellent does not make the bait more appealing to other non-target species.

4.6. TAMPER-PROOF BAIT STATIONS

- Use a bait station designed to decrease the interference from non-target species on the bait stations.
- Care must be taken to ensure that the bait remains easily available to the target species.
- Fully investigate any designs by trialling the bait stations on the island to ensure they work as planned for the particular non-target species but are still used by the target species.

4.7. TIMING OF ERADICATIONS

- Used to avoid the problem of invasive species eating the bait.
- If the non-target species that eats the bait migrates away from the island during part of their lifecycle, timing the eradication to coincide with their absence will avoid the problem of interference.

5. LAND CRABS

- Land crabs have proven to be a major issue for many eradication projects in the Pacific.
- As land crabs are unique to the tropics, this issue is not seen in temperate and sub-Antarctic eradications.

5.1. KNOWN ISSUES

1) Land crabs reduce the amount of bait available to the target invasive species by eating large amounts of bait.

- Reported daily bait consumption rates for individual crabs range from 3.7 g per day for *Cardisoma sp* (Howald et al. 2004), to 10 g per day for *Coenobita* sp. (Thorsen 2007). Combined with high crab densities this can result in large daily bait consumption rates. For example, with a population density of 3,600 per hectare (observed on Aldabra Island) and an individual daily consumption rate of 10 g per day, results in a total daily consumption rate of 36 kg per hectare.

2) Land crabs reduce the amount of bait available to the target invasive species by interfering with bait stations.

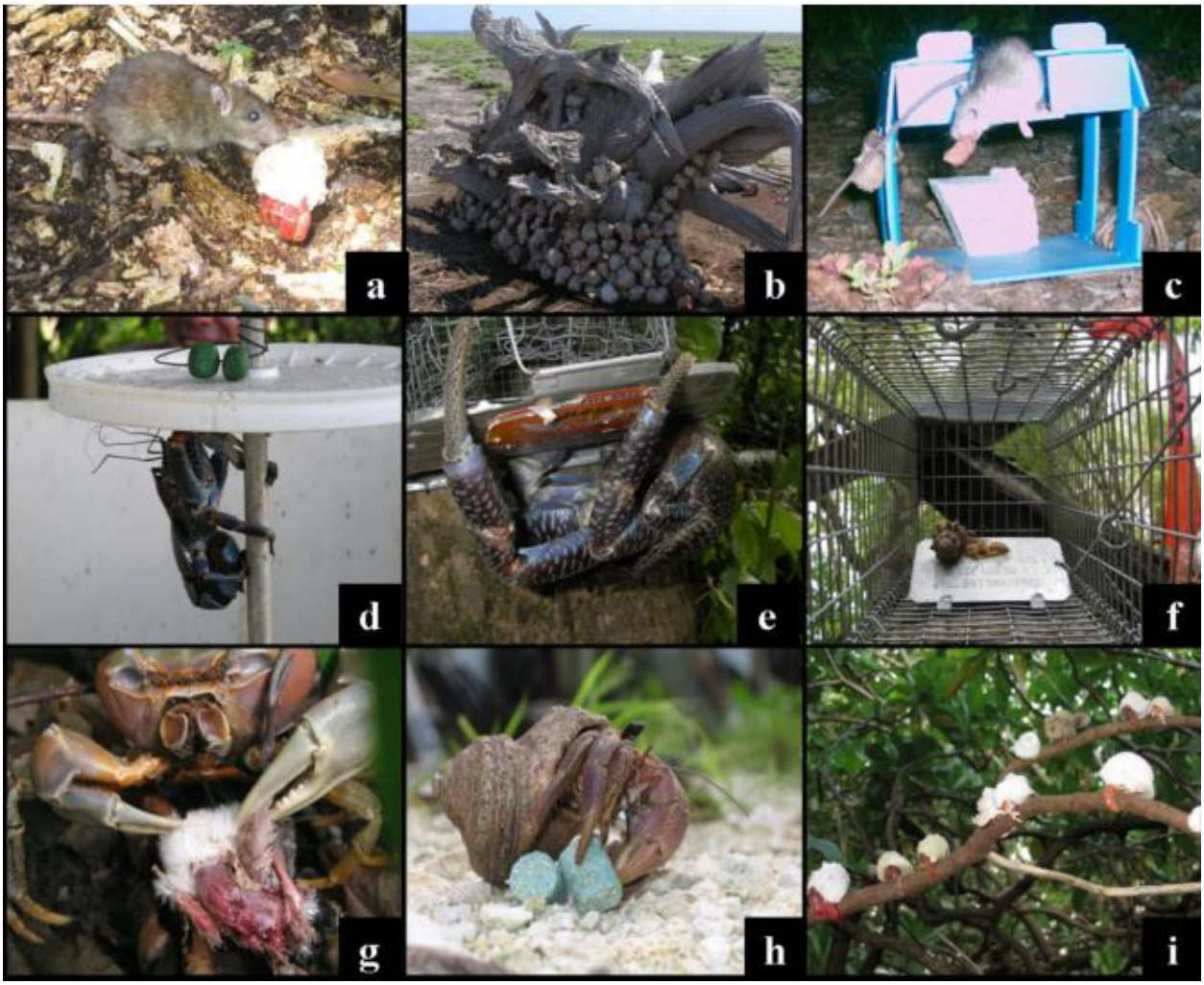
- Reports of land crab interference with bait-stations primarily involved *Coenobita* and refer to social aggregations and piling behaviour

- Coconut crabs are very strong. They can exert about 1.5 times the force of a human bite and can shear sticks up to 5cm in diameter. Bait stations may not withstand constant attack. Large crabs can rip apart 5-gallon plastic buckets and demolish Protecta® bait-stations to access the enclosed bait.

3) Risk of secondary poisoning of other non-target species.

- By ingesting large amounts of bait, land crabs may become a secondary pathway for the exposure of anything that preys on or otherwise consumes the crab (e.g. a native bird, other crabs and people). A research study on the effects of brodifacoum on a land crab (*Gecarcinus lagostoma*) native to Ascension Island, identified that immediately after feeding on brodifacoum-based bait their bodies contained low levels of brodifacoum (Pain et al, 2000). No residues were detected in any body tissues 1 month following exposure.
- Coconut crabs are a particular issue because they are a highly esteemed human food source.

Examples of land crabs interfering with eradications



a) *R. rattus* attacking *C. perlatus* at Palmyra Atoll; land crab carapace pieces are common items in rat husking stations – rodenticide toxins can move through land crabs to rats or non-target species (Island Conservation)

b) *C. perlatus* pile in the Phoenix Islands; *Coenobita* will pile to access desired resources, ranging from shade to bait in a bait-station (R. Pierce – Eco Oceania Ltd)

c) R. rattus with a chunk of coconut exiting a Rat-Go® bait-station while *C. brevimanus* attempt to enter the station at Palmyra Atoll; bait stations that provide an overhanging entrance are more robust against land crab interference (Island Conservation)

d) *B. Latro* testing an experimental bait-station at Palmyra Atoll; the crab eventually accessed the bait – designing a crab-proof bait-station that is also accessible to all individuals of the target population is a serious challenge (D. Vice – USDA)

e) A small *B. Latro* disabling a tree-mounted Hagaruma® rat trap at Pohnpei; land crabs frequently interfere with trapping efforts – elevating traps on plastic buckets or mounting them to trees will discourage all but the most determined crabs (Island Conservation).

f) A small *C. brevimanus* avoids entrapment while consuming peanut butter bait from a Tomahawk® rat trap at Pohnpei; small crabs, especially *Coenibitids*, readily rob bait from live-capture traps; elevating traps and checking trigger sensitivity can all but eliminate this problem (Island Conservation)

g) An adult *Cardisoma carnifex* consumes a Sooty Tern (*Sterna fuscata*) chick at Palmyra Atoll; gecarcinids and coenibitids are capable scavengers, and will readily consume rat carcasses – land crabs experience indirect exposure to rodenticides through scavenging carcasses (Island Conservation)

h) An adult *Coenobita brevimanus* consumes one 2.3 gram bait pellet while hording another at Palmyra Atoll *(Island Conservation)*

i) *Coenobita perlatus* resting on *Tournefortia argentea* branches at Palmyra Atoll; All *Coenibitids* including *B. Latro*, are proficient climbers; if elevating bait-stations or traps by securing them to trees, select large-stemmed, smooth-barked trees (Island Conservation).

5.2. RELEVANT ECOLOGY

- On many Pacific islands, large numbers of land crabs have been seen to readily feed on bait intended for rats.

- Due to their blood chemistry, anticoagulant poisons (including brodifacoum) do not present a danger to land crabs. This can result in crabs repeatedly feeding on bait and consuming large quantities.

- Land crabs can reach high numbers in the absence of heavy predation and can be the dominant animal species on islands where there are few mammals and birds. For example, on Aldabra Island in the Seychelles – *Cardisoma carnifex* can reach densities of over 3,600 per hectare, with an average individual mass of 322g.

- Land crabs have two basic foraging modes. The more lightly armoured crabs that depend on speed and agility for defence tend to be active predators and facultative scavengers. Heavily armoured crabs are usually more sluggish and tend to feed mostly on inactive items; since there are few sessile animals on land, these crabs are primarily herbivores (only eat plant matter) or detritivores (only eat dead matter [plants and animals]; most of these herbivores / detritivores also scavenge carrion whenever possible.

- Hermit crabs often feed in large groups – this can mean that they can potentially monopolise dense pockets of bait following an uneven bait broadcast. They also tend to sit on top of one another and this stacking behaviour can have implications for crab proof bait stations.

- Coconut crabs can forage 30m or more from their burrows and are capable of robbing or dismantling bait-stations. One crab can have several burrows within its territory and so each bait-station will likely be subject to attacks from more than one individual.

- It may be the case that rat predation of land crabs and direct competition for resources has led to a shared, but temporally divided niche space; land crabs will not be directly competing with rats for bait if they are more diurnal and the rats nocturnal. In a broadcast scenario, bait applied during the day could be subject to several hours of crab foraging before most rats become active (this was the case at Palmyra Atoll).

- The *cardisoma* crabs can take bait to their burrow – this could result in caching of bait. If you have this species present you need to get some idea of how much this occurs as it could make bait permanently unavailable to rats through the creation of gaps in bait availability

- Because breeding can occur year round in the tropics it makes it difficult to time eradication projects during periods of 'low' land crab abundance.

5.3. SPECIES KNOWN TO INTERFERE WITH ERADICATIONS

- DO INTERFERE: Land crabs in the families Coenobitidae (coconut and hermit crabs) and Gecarcinidae (burrowing land crabs)

- DO NOT INTERFERE: Land crabs in the families Grapsidae and Ocypodidae

Table 1 summarises this knowledge:

Common name	Family	Genus	Species	Eats bait	Interferes with bait stations*
Coconut crab	Coenobitidae	*Birgus*	*latro*	√	high
Hermit crabs		*Coenobita*	*brevimanus*	√	moderate
			cavipes	√	moderate
			perlatus	√	moderate
Burrowing land crabs	Gecarcinidae	*Cardisoma*	*carnifex*	√	low
			hirtipes	√	low
			guanhumi	√	low
			longipes	√	low
			rotundum	√	low
		Epigrapsus	*notatus*	√	low
		Gecarcinus	*lateralis*	√	low

			planatus	√	low
			ruricola	√	low
		Gecarcoidia	*lalandei*	√	low
Predatory land crabs	Grapsidae	*Geograpsus*	*crinipes*	X	none
			grayi	X	none
Fiddler crabs	Ocypodidae	*Uca*	spp	X	none
Ghost crabs			spp	X	none

* assuming bait stations are robust, raised and anchored.

5.4. MANAGEMENT OPTIONS

- Land crab interference with eradication efforts is a serious challenge unique to the tropics, thus eradication projects on tropical islands should not be strictly modelled after eradication projects on islands outside of the tropics and without land crabs.

- A diverse land crab community increases the mitigation challenge for eradication projects. For example, burrowing land crabs generally do not interfere with bait-stations, while Hermit and Coconut crabs do; a mixture of burrowing species and Coenobitas and/or Birgus could require heavy application rates for a bait broadcast, or complicated and potentially rat limiting bait-station designs.

- Toxin-based eradication projects on islands with permanent human settlements must mitigate for the risk of human exposure to toxins through the consumption of land crabs.

5.4.1. INCREASE BAIT RATES

- Useful to combat land crab consumption of bait.

5.4.2. USE OF BAIT STATIONS

- Get advice as to which bait stations are most successful in your environment –eradication must target every individual.

- The use of bait stations on crab islands is affected by:

    - Coconut crabs can dismantle just about any easily manufactured, easily transported bait station

- Bait stations with complex crab exclusion devices or structures are also at high risk of excluding individuals of the targeted invasive species (e.g. rats, mice)

5.4.3. USE OF BAIT MASKS

- Some crab species may be repelled by certain smells but bait masks must not repel animals of the target invasive species. Check with PII as to whether this work has been advanced. Any bait mask would have to ensure that:
  - The scent or bait mask cannot increase the risk of toxin exposure for other non-target species
  - In multi-crab species environments, the bait mask would need to be effective for all crab species

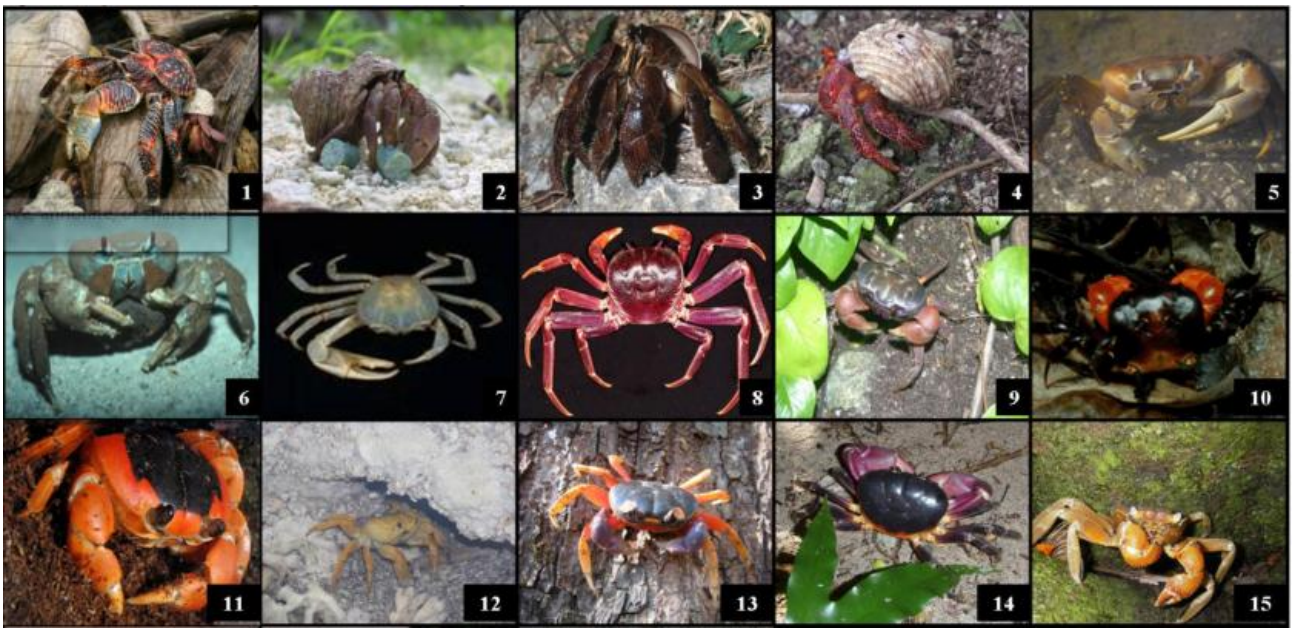
5.4.4. TIMING OF ERADICATION

- Knowledge of the breeding cycles of the species of crabs on your island may help determine better times to undertake an eradication operation. Many species have a marine stage. If you can predict these migrations it might be possible to decrease crab interference by baiting on, or just before, a mass migration

5.4.5. NO TAKE/HARVEST

- Useful for addressing the risk of secondary poisoning to people.

5.5. IDENTIFYING CRAB SPECIES



Reproduced from Wegmann (2008).

1) *Birgus Latro (*E. Nonner – USFWS); 2) *Coenobita brevimanus* (Island Conservation); 3) *Coenebita cavipes* (www.flmnh.ufl.edu); 4) *Coenebita perlatus* (Island Conservation); 5) *Cardisoma carnifex* (Island Conservation). 6) *Cardisoma hirtipes* (www.bio.bris.ac.uk); 7) *Cardisoma guanhumi* (www.dnr.sc.gov); 8) *Cardisoma longipes* (www.access.nrp.fr); 9) *Cardisoma Rotundum* (E. Nonner- USFWS); 10) *Epigrapsus notatus* (www.study.nmmba.gov.tw); 11) *Gecarcinus lateralis* (www.crusta.de); 12) *Gecarcinus planatus* (www.photozoo.org); 13) *Gercarcinus ruricola* (www.wikipedia.com); 14) *Gecarcoidea talandeil* (S. Klain – US Peace Corps); 15) *Geograpsus crinipes* (Island Conservation); 16) *Geograpsus grayi* (Island Conservation); 17) Uca sp. (Island Conservation); 18) Ocypode sp. (www.isle.net)

6. BIRDS

7. LIZARDS

8. FISH

9. SHELL FISH

10. TURTLES

11. BATS