

TOKELAU Kimoa/Rat, feral pig and feral cat eradication OPERATIONAL PLAN



Figure 1 – a boar feeding on a coconut pile on Te Puka I Muli, Nukunonu, Tokelau, October 2023.

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Introduction

This operational plan presents the methodology and logistics for executing eradications of Pacific rats (*Rattus exulans*), Feral pigs (*Sus scrofa*) and feral cats (*Felis catus*) in Tokelau. This document stems directly from a feasibility report completed in January 2024. For details on the site, biodiversity values, the target species etc, please refer to the feasibility report.

Planning issues and dependencies that must be resolved in the planning stage of the eradication were identified in the feasibility report. Pre-eradication trials were proposed to resolve questions around tools and techniques; the methodology for these trials is developed in Section 1 below.

This should be used as a “living document”, the contents of which will inevitably change as planning for the eradication proceeds and as the results of pre-eradication trials are reported.

Section 1 - Feasibility trials 2024

Trial ground-based eradications of rats and feral pigs are proposed in Nukunonu, on 17.5 ha encompassing Te Puka I Muli, Te Kamu and the interconnected motu in between (see figure 2 below).

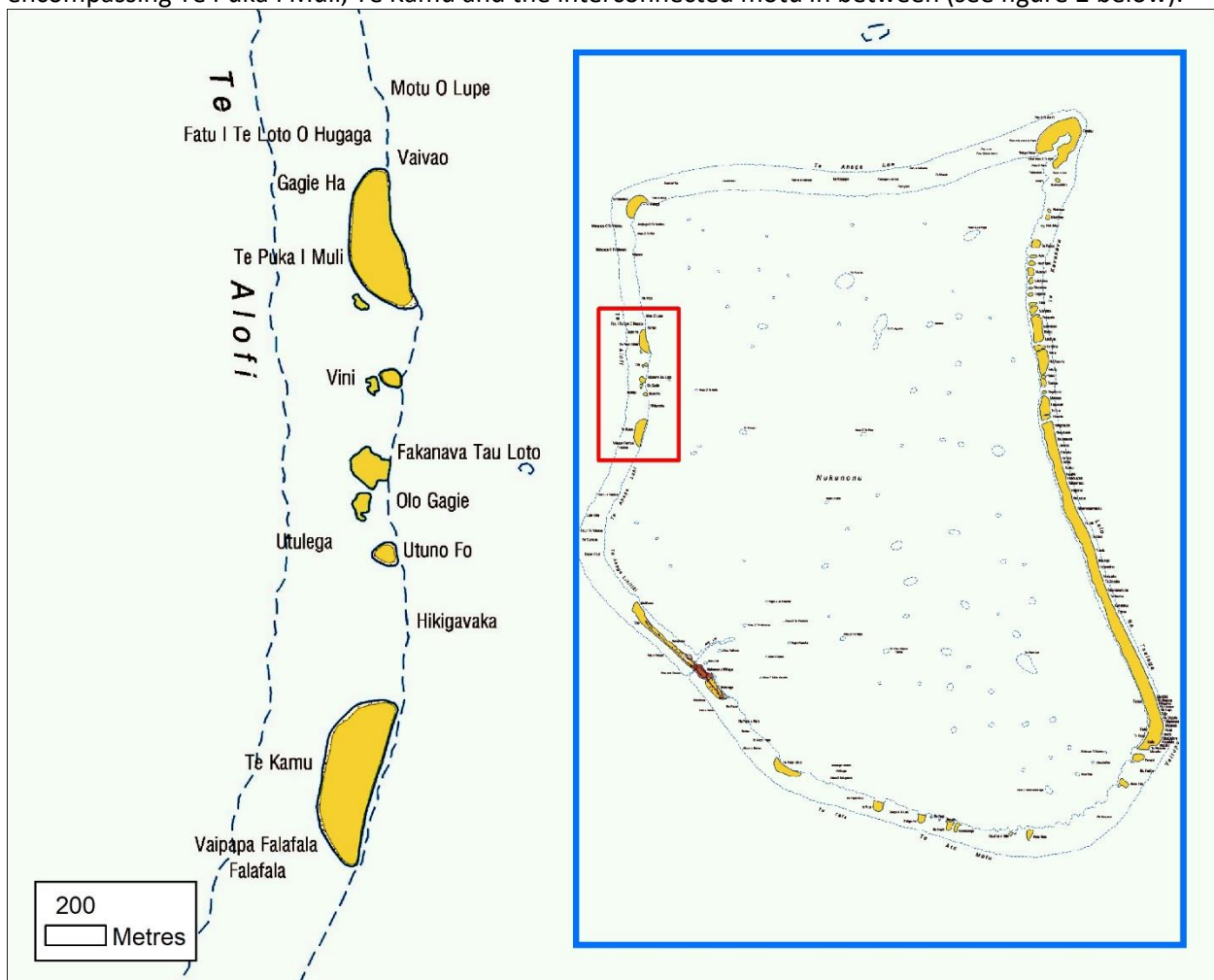


Figure 2 – proposed feral pigs and rat eradication trial site, Nukunonu.

This site is ideal for the eradication trials because:

- It is well outside the known swimming range of *Rattus exulans*, so the chance of reinvasion is minimal.
- The site is easily accessible from Nukunonu village where the field team will be based.
- Both pigs and rats are present. The impact of both species on the vegetation and animals of this site are obvious.
- These motu are communally owned so the benefits of eradicating rats and pigs will be observed by the whole community.
- Rat abundance here was the highest seen in Tokelau from the motu sampled during a feasibility visit in 2023, so this is an excellent site to trial the effectiveness of proposed tools.
- Anticoagulants have not been used at this site for at least 18 months so there is no possibility of bait shyness.

FERAL PIGS

The feasibility report proposed:

- Trial an eradication of feral pigs using passive tools on isolated motu in Tokelau during 2024. Assess the effectiveness of these tools under local conditions.

Methodology

It is necessary to undertake the eradication of pigs before rats are targeted. The methodology proposed is based on trials conducted on a coral atoll in the Marshall Islands, on a tropical islet in Wallis and Futuna and on monitoring carried out on Te Puka I Muli and Te Kamu in 2023. No toxin will be used and all pigs killed can be recovered to be used for food by the community.

Ambush method

Pigs will initially be pre-fed with piles of opened coconuts at about fifteen sites spaced approximately 150m apart (see figure 3 below). It is expected that if coconut piles are replenished daily for 3-4 days without disturbing pigs, individuals will readily return each day/night at regular and predictable intervals. During an initial monitoring phase trail cameras will be used to monitor the food piles and photos will be analysed to identify individuals and estimate the time of day or night they can be expected to return to the food pile. Based on observations in 2023 most pigs are expected to be on their own – these individuals would be targeted by shooting from a pre-planned ambush site overlooking the coconut pile. The location of the ambush site will take account of the prevailing wind to minimize human scent. If groups of pigs are present, they will be targeted with net traps rather than shooting, as it is unlikely that more than one pig out of a group can be shot at close range in forested habitat.

A high-powered bolt-action rifle fitted with a sound moderator and a thermal scope would be used to shoot pigs. This tool would only be used by an experienced marksman as it is highly important that pigs are dispatched first time and not missed and allowed to escape, as pigs will certainly change their behaviour after a negative experience and become much harder to eliminate. It is also vital that pigs remain naïve prior to the eradication attempt. It is very important that they should not be chased or pressured so that they behave naturally. During the pig eradication attempt the number of people on the motu should be minimized to keep human noise and scent down. Much of the shooting will be done

at night due to the mainly nocturnal habits of feral pigs, so it will be necessary to set up a basic camp on the island.

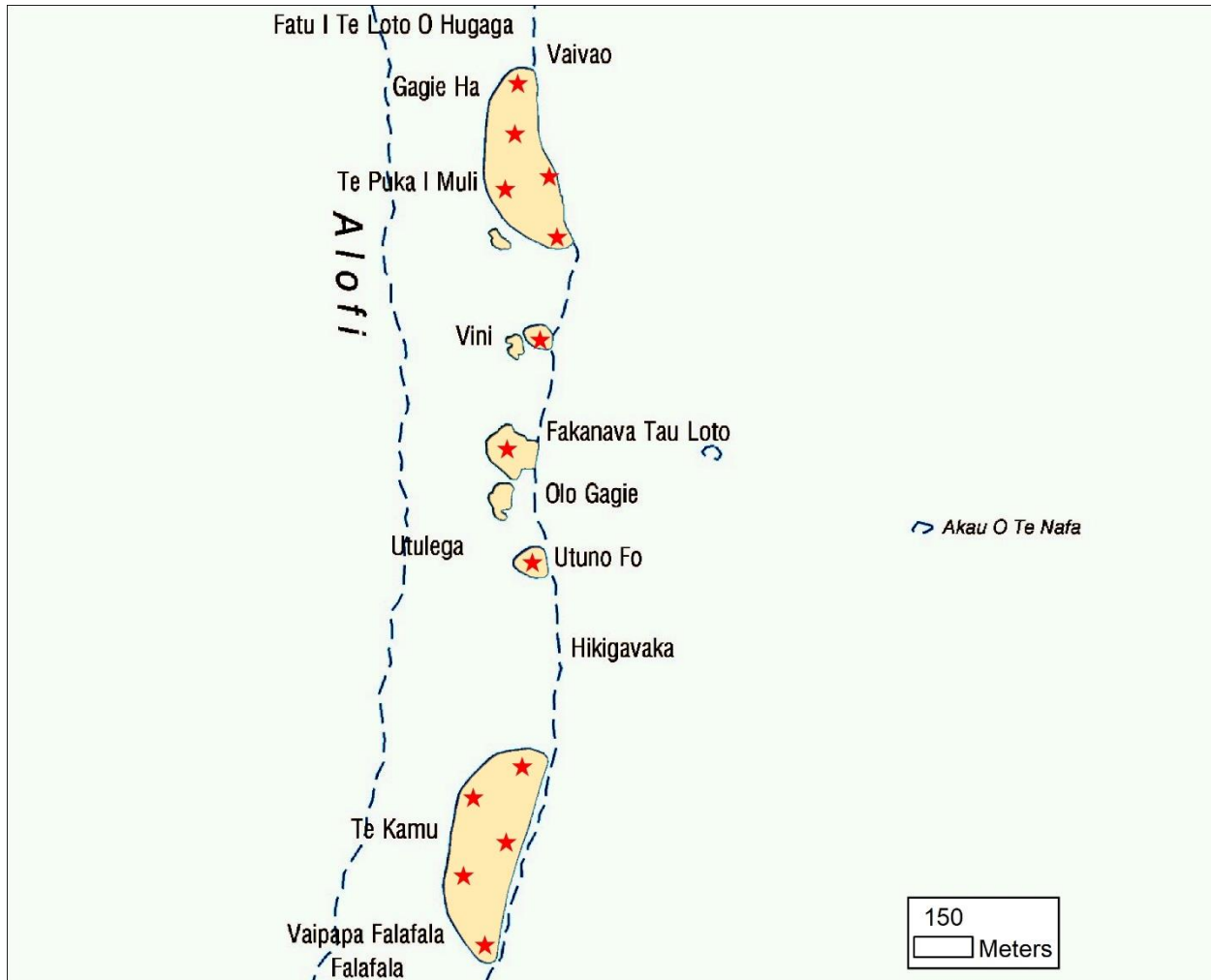


Figure 3 – Proposed grid of cameras, feasibility trial site.

Net traps

If groups of pigs are detected on camera during the initial monitoring phase then net traps will be employed as they are the preferred tool for capturing groups of pigs. Pig-brig traps will be placed and pre-baited for a period with opened coconuts and monitored with a trail camera to observe pig interactions, before setting the trap once pigs are feeding regularly without trepidation.

Snares

Snares are a passive tool that are used widely in New Caledonia and Hawaii to reduce populations of feral pigs. Depending on the pace of progress of removing pigs with shooting and net traps, snares could be used simultaneously. They could also be used to target individuals that may be trap or bait shy. Site selection is very important – snares work most effectively when set on regularly used game trails. Snares will be set by an experienced staff member to minimise the chance of escapes.

RATS/KIMOA

Two trials at the same study site are proposed:

- Conduct a ground-based eradication to trial the uptake by rats of the recommended bait formulation on isolated motu on Tokelau during 2024.
- Conduct a bait availability trial at the recommended bait application rate on Tokelau in 2024.

Methodology

Following the removal of feral pigs, the rat eradication trials will proceed as follows. A grid of points at 20 x 20 metre spacing (see Figure 4) will be established across the study site using Real Time Kinematic (RTK) surveying equipment. Pellet bait containing 25ppm of the rodenticide Brodifacoum will then be distributed by hand at each grid point. A team of local workers will be trained by two staff from Island Conservation to set-up the grid and conduct the baiting. Workers will be split into three-person teams to carry out the work, with a team leader nominated for each group of three. Set-up of the grid is expected to take no more than 5 days and baiting no more than 2 days for each application. **Appendix x** details a step-by-step methodology for this work.

Table 1 – Metrics of the proposed trial eradication sites

Motu (North to South)	Size (ha)	Perimeter (m)	No. points
Te Puka I Muli	6.3	1135	159
Te Puka I Muli (west)	0.1	164	3
Vini	0.3	215	8
Vini (west)	0.2	191	4
Fakanava Tau Loto	1.2	431	9
Olo Gagie	0.4	272	10
Utuno Fo	0.5	261	10
Te Kamu	8.5	1315	213
TOTALS	17.5	3983	416

A baiting rate of 25kg of bait per hectare will be trialed across the site. Two applications of bait will occur, (a minimum of 18 days apart) totaling 50kg per hectare. Staff will broadcast five 200-gram cups of bait at each point, totaling one kg of bait per point per application. An additional application of bait will be made on the coastline immediately behind the beach. Here one 200-gram cup of bait will be broadcast inland every 10 metres. No bait will be broadcast onto the beach, reef or into the sea. Bait quantities required are detailed in Table 2 below.

Table 2 – Bait quantities for the proposed rat eradication trial.

Zone	Calculation	Bait (kg)
Hand broadcast at baiting points 50kg/ha	17.5ha x 50kg/ha	875
Coastal fringe hand broadcast, 200g/10m	3983m /10 x 200g /1000	80
Contingency 10%	955 x 0.1	96
TOTAL		1051

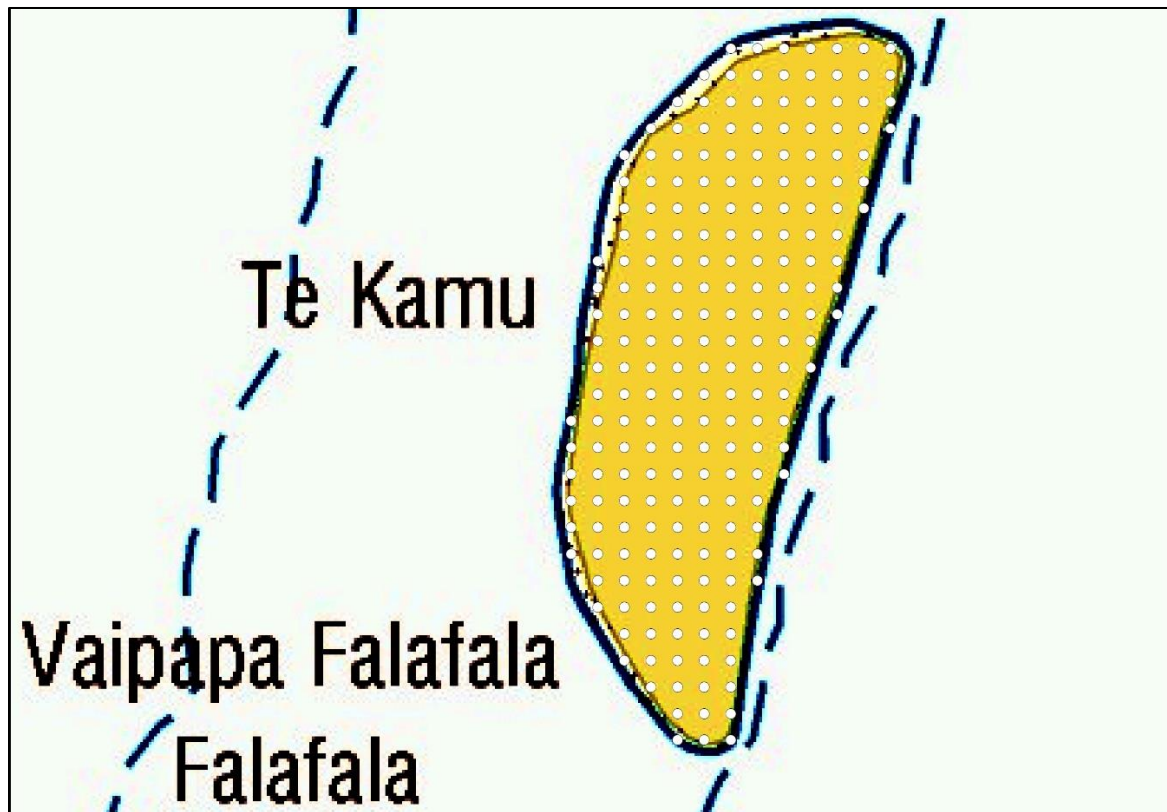


Figure 4 – diagram of proposed 20m x 20m grid on Te Kamu

Bait availability between the first and second application of bait will be measured setting up plots of 25m long x 1m wide and marking a representative sample of bait pellets inside the plots with pin flags. The number of pellets remaining each day will be recorded for at least the first seven days after bait application. Information from this monitoring will be used to judge whether enough bait is available for a sufficient length of time to put all individual rats at risk.

Bait availability plots will be installed prior to baiting and will be run from the first day of baiting, allowing the team to monitor how quickly bait is disappearing. A total of 30 plots will be established across the site and all vegetated habitat types will be sampled. Plots will be established using a transect tape to measure out the plots; blue pin flags will be used to mark the perimeter of the plot; pink flags will be used to mark the bait pellets.

Immediately after bait distribution, the bait availability plots will be assessed for number of pellets. Each pellet encountered in the 25m² plot will be marked with a pin flag. Each bait availability plot will initially be calibrated to represent the 25kg/ha application rate. Staff will aim to have entire pellets (i.e. not fragments of pellets) within the plots. Each subsequent day for seven days after the bait application availability plots will be checked within the same general time of day for disappearance of pellets. As pellets disappear flags will be removed and the number of pellets remaining in each plot will be recorded daily into a bait availability data sheet. Pellets that have been reduced in size by more than half will also be removed from the plot. Notes will be recorded on the condition of the bait each day including colour, hardness and whether the baits are being consumed by insects.

Based on an application rate of 25 kg/ha and an average pellet weight of 2.3 grams each plot should have an average of 27 bait pellets after the broadcast occurs ($25000\text{g/ha} / 2.3\text{g} = 10870$ pellets per ha. $10870/10,000 = 1.09$ pellets per $\text{m}^2 \times 25 = 27.3$ pellets per 25 m^2 plot).

FERAL CATS

A trial of tools to eliminate feral cats were proposed in the feasibility study as follows:

- Trial cat removal techniques e.g. leghold trapping and test non-toxic bait delivery technique on Tokelau.

Following the completion of the feral pig and rat eradications at the trial site feral cat trials will be undertaken at a second site. This could be on Nukunonu – e.g. the motu of Te Fakanava, Tokelau or Fenua loa, or it could be on Atafu e.g. the motu of Na Utua, where cats were detected in high numbers in October 2023. Selecting a trial site on Atafu would necessitate the two staff from IC coordinating the timing of the work to match the schedules of the Mataliki and Kalopaga.

Methodology

The removal method trialed will be victor 1.5 leghold traps set on top of buckets filled with sand (the buckets will be recycled from the rat eradication). This method has been widely used in the tropical Pacific to capture cats whilst minimizing interference with traps by land crabs.



Figure 5 – leghold trap set in bucket and cat captured in leghold, Palau, 2019.

Trap sites will be overlooked with trail cameras. At half of the sites buckets will be pre-fed for two days before traps are set, at the other half traps will be installed on day one. Trap sites will be overlooked by trail cameras to study cat interactions with the bucket/trap.

The leghold trap is considered to be humane and is widely used to target a variety of mammals. The victor 1.5 has a rubber lip on the jaw of the trap, which holds the cat firmly without causing injury. Cats caught will be dispatched humanely by an experienced operator.

Methodology for delivering toxic bait to cats to eliminate crab interference will also be trialed using a non-toxic proxy (sausages). Sausages will be suspended from tree branches on strings at pre-fed sites and overlooked by trail cameras to study cat interactions with the bait.

TIMELINE FOR ERADICATION TRIALS

Table 3 – timeline of proposed eradication trials

Day	Date	Target Animal	Activity	Number of staff
1-4	September 1 st – 4 th	Feral pig	Set-up cameras on coconut piles, re-bait daily. Download camera data and analyse.	2 IC, 2 EDNRE, 2 local workers
5-20	September 5 th – 21 st	Feral pig	Eradicate feral pigs	2 IC, 2 EDNRE, 2 local workers
15-20	September 16 th – 21 st	Rat	Training local team	2 IC, 2 EDNRE, 8 local workers
21-24	September 22 nd – 24 th	Rat	Set-up 20x20m grid and bait availability plots	2 IC, 2 EDNRE, 8 local workers
25-26	September 25 th – 26 th	Rat	Bait application 1	2 IC, 2 EDNRE, 8 local workers
25-32	September 25 th – October 1 st	Rat	Monitor bait availability plots Conduct baseline monitoring	2 IC, 2 EDNRE, 8 local workers
33-44	October 2 nd – 12 th	Feral cat	Conduct cat tool trials	2 IC, 2 EDNRE, 2 local workers
45-46	October 13 th – 14 th	Rat	Bait application 2	2 IC, 2 EDNRE, 8 local workers

MONITORING

It will be important to establish baseline monitoring to measure the outcomes of the rat and pig eradication on these motu. Because these motu are held as a communal food reserve they are a good place to demonstrate the benefits of eradication including recruitment of coconut trees and increases in crab abundance. Both variables are expected to show a rapid response to the removal of rats and pigs. This work will be completed by a local team mentored by Island Conservation staff.

Table 4 – Proposed baseline outcome monitoring for eradication trials 2024

Study	Sampling Method	Islets sampled	Sample Size per Islet
Seabird nesting	Nesting seabirds (10m plot)	Te Puka I Muli, Te Kamu	15 plots
	Count of nesting seabirds (circumnavigation of perimeter)	All islets	
Vegetation	Coconut seedling/sapling counts (10m plot)	Te Puka I Muli, Te Kamu	15 plots
	Photographs in 4 cardinal directions and ground cover	Te Puka I Muli, Te Kamu	15 plots
	Vegetation description	Te Puka I Muli, Te Kamu	15 plots
Emoia skinks	Strip transect (20m x 1m)	Te Puka I Muli, Te Kamu	20 consecutive plots
Landcrabs	Strip transect (20m x 1m)	Te Puka I Muli, Te Kamu	20 consecutive plots

LOGISTICS

Bait purchase, transport and storage.

Bait will be manufactured by Bell Labs in Windsor, Wisconsin, USA. Bait will be packed into 93 x 25lb/11.3 kg buckets, stacked into a 20-foot shipping container and transported overland to Long Beach California, from where it will be shipped to Apia, Samoa. From Apia the container will travel to Nukunonu on the MV Kalopaga. The buckets of bait will be offloaded onto the barge offshore at Nukunonu and transported to the wharf from where they will be moved into dry, rodent-proof storage (site to be confirmed).

Local staff.

A team of at least eight local staff will be required for about 2 weeks (including training) to complete this work. Workers selected will need to be fit for bush work and have a good attitude for the work as the success of the trial largely depends on them. The rate of payment for staff will need to be determined in discussions with community leaders in Tokelau.

Accommodation and camping

Two IC workers would need to be accommodated on Nukunonu (and potentially Atafu for a shorter period). A camp would need to be established on either or both of Te Kamu and Te Puka I Muli for the period of the pig eradication.

Management of Gear

Electronic equipment will need to be downloaded and recharged daily, this work could be done at either the EDNRE offices or at the accommodation for the IC staff. There will be opportunities to train interested local workers in these tasks to upskill individuals for data and gear management roles in the proposed eradication.

Transport

A dinghy would be required to be available daily during the feral pig eradication trial and two vessels would be required to transport people and gear for the rat work.

Fuel and oil

Sufficient fuel and oil would be required to service the dinghy trips back and forth to Nukunonu village.

Food and water and resupply of pig camp

Whilst in Nukunonu village it is expected that meals can be purchased through local caterers. At the pig camp food and water could be resupplied by daily dinghy trips from Nukunonu village.

Communications

Communication between the field teams will be by UHF radio. Teams will be working 20 metres apart so, if necessary, it will also be possible to shout to neighbouring teams. Each team leader will have a handheld UHF radio on which they communicate with or be reached by other team leaders and the Technical Lead.

Baiting - weather

Weather forecasts will be consulted every day before and during the rat eradication trial. If significant rainfall is forecast, then broadcast of bait will be delayed until the rain has passed.

GIS and data management

There will be a significant amount of spatial and monitoring data to manage. This will need to be downloaded and backed-up regularly. This will provide another excellent training opportunity for upskilling individuals who show an interest in this work and could fill these roles during the proposed eradication.

SAFETY OF STAFF AND COMMUNITY MEMBERS

Safety of the Operational Team

Thinksafe protocols will be used to ensure safety during the operations. All project participants will be inducted and will review the relevant risk assessments. The Thinksafe App will be used by project

participants to understand the hazards on site and the mitigations required, and to report near misses, unsafe acts, positive acts etc. A briefing will occur each morning and all participants will have the opportunity to discuss any safety concerns – hazard cards will be reviewed at these meetings. If an incident occurs first aid will be administered, and the emergency management protocols will be followed (protocols to be developed).

Quantities of bait stored, used and disposed will be tracked using the App, which will automatically update the Hazardous Substances Register (to be developed).

Equipment will be available to mitigate hazards encountered in the field. Boats will be maintained in good working order and life jackets will be available for all passengers. Hard hats, safety goggles and gloves will be worn whilst cutting and marking the lines. Broad-brimmed hats (worn under hard-hats) and sun protection will be worn. PPE i.e. nitrile gloves and long sleeve shirts, will be worn when handling rat bait as specified on the SDS and product label. UHF radios will be carried by each three-person team and communications will be maintained throughout the workday.

Fresh water will be carried in the boat and each team member will carry at least 2 litres of water. Hard-soled shoes or sandals will be worn whilst wading due to the risk of stonefish, rays and coral. A 10-person first aid kit will be carried amongst the field team and another one will be available at camp. A bleed-control kit will be carried by the technical lead.

In the event of a medical emergency, first aid will be administered if safe to do so. There will be trained first-aiders on the team and as the teams will be working very close together (within 200 metres) first aid should be available almost immediately. A primary check will be carried out – check for dangers, assessment of responsiveness, then assessment of Airway/Breathing/Circulation (ABC). If CPR is required it will be administered until contact has been made with medical staff. Once ABC are secure a secondary survey will be performed, topical treatment will be administered and the patient/s will be kept comfortable and monitored.

If evacuation is required the dinghy can be used to rapidly transport a patient back to Nukunonu for care at the medical centre.

Safety of Island communities

Bait will be securely stored in a locked container in Nukunonu to prevent access by children. Firearms will also be locked and stored out of sight when not in use. Ammunition and bolts will be stored separately from firearms.

Community consultation will take place to highlight hazards posed by the operation and precautions required. Warning signs explaining the hazards posed by rodent bait will be placed at all normal entry points to the motu.

A 6-month moratorium will be imposed on the harvesting of crabs from the motu where the eradication trial will take place.

NON-TARGET SPECIES

Crabs

A proportion of bait will be consumed by crabs, particularly where there is a high density of burrowing land crabs (e.g. *Tuerkayana rotundum*), however crabs are not susceptible to the toxicant and no impact on crab populations is expected.

Birds

Shorebirds are a non-target species of concern on many pacific islands, however as the islets are largely forested and bait is being hand-laid above the high-tide mark, this operation is expected to have no impact on shorebirds. Some individual wading birds Pacific Golden Plovers (*Pluvialis fulva*) and Bristle-thighed curlew (*Numenius tahitiensis*), could be at risk through secondary poisoning by consumption of crabs that have consumed bait, however it is expected that low numbers of both species use the motu within treatment area and the species will not be at risk at a population level. The operation will be of benefit to populations of wading birds as crab numbers can be expected to increase greatly once rats and pigs are eradicated.

Reptiles

Reptiles such as skinks and geckos are likely to be present on the islets. Gecko mortality has not been recorded previously as a consequence of rodent eradications where rodent bait has been applied aerially and the risk of primary or secondary poisoning to both geckos and skinks is anticipated to be low (Withers, T et al.). If primary and secondary sub-lethal exposure does occur, low level brodifacoum residues are expected to persist in reptiles for an extended period. However, these residues are not considered a significant risk to other fauna as secondary consumers (mainly birds) are in low numbers on the islets.

ENVIRONMENTAL EFFECTS

Baits containing brodifacoum remain toxic until fully broken down, with the rate of decay depending on the amount of rainfall (Department of Conservation, 2007). Baits will eventually disintegrate, causing the brodifacoum to be absorbed into the soil. It will then be slowly degraded over an extensive amount of time (weeks to months) by soil bacteria. Soil type, temperature, and the presence of soil micro-organisms capable of degrading brodifacoum will all influence the degradation time. The low solubility of brodifacoum in water means that plant uptake is unlikely. The bait may be present on site for longer than 35 days due to the durability of the product (Withers et al. 2017).

It is important to note that brodifacoum has very low solubility in water, so leaching from soil into water is unlikely to occur. Only soil erosion would result in brodifacoum reaching water. If soil containing brodifacoum reached a waterway, the brodifacoum is likely to remain bound to organic material and settle out in sediments. Brodifacoum also degrades slowly (weeks to months) in natural water and the presence and type of sediment layers will affect the degradation process. In New Zealand, when baits were broadcasted into streams during previous pest eradication operations, it was observed that there were no brodifacoum residues in the water (Department of Conservation, 2007). Due to the very low solubility of brodifacoum it cannot be up taken by plants.

OPERATIONAL TEAM

Table 5 – Operational team for eradication feasibility trials

Name	Role	Responsibilities	Training required	Availability
EDNRE staff # 1				
EDNRE staff # 2				
Paul Jacques	Project Manager, Island Conservation	Technical Leadership		
Cielo Figuerola	Island Restoration Specialist	Technical Leadership		
Local worker # 1				
Local worker # 2				
Local worker # 3				
Local worker # 4				
Local worker # 5				
Local worker # 6				
Local worker # 7				
Local worker # 8				

BIOSECURITY

Prior to the eradication trial a biosecurity plan to prevent re-invasion by rats and re-release of pigs must be developed in partnership with EDNRE, the Taupulega and the community. This work will involve education of all stakeholders as to the risks of introduction of invasive species and the actions that need to be taken to prevent introductions, including how to inspect boats, cargo and gear for rodents and rodent activity, how to treat a rodent infestation on a vessel and who to report the information to.

There is an increased risk of introducing foreign species (e.g. weed species) to the motu during the operation and therefore there is need for the operational team to follow strict biosecurity protocols. From the onset of the operation, the islets should be treated as if they are rat free, this will help instil good biosecurity practices amongst the team. All workers will be oriented in appropriate screening processes and instructed to maintain this protocol for the duration of the trial eradication.

Before every trip all gear will be checked prior to loading the boat, no open cardboard boxes will be brought to the island. A biosecurity lead will be nominated to ensure biosecurity checks are completed and potential incursions of invasive species are appropriately responded to.

ERADICATION CONFIRMATION

The islets will be visited one year following bait application to confirm if the trial rat eradication operation was successful. Detection methodology for confirmation will be a combination of trail cameras, snap traps and spotlight surveys.

Validation of the success of the pig eradication will be achieved by leaving out a grid of trail cameras to monitor for remaining pigs and to confirm the absence once no remaining pigs have been detected after a period of months.

EQUIPMENT LIST

Feral pig eradication trial

Pig Brig trap x 2
Rope for snares
Trail cameras x 15
SD cards x 30
Camera for checking SD cards
Laptop, hard drive
Rifle, scope, sound moderator x 2
Thermal Scope x 2
Ammunition x 200 rounds
Hunting knives x 3
Torch x 2
Camp chair x 2 (for ambush)
Camp gear – tents, mosquito nets, sleeping mats, cooker, pans, cutlery, chairs and table
Solar panel for charging torches etc at camp
Water containers
Radios
GPS units x 2
First aid kit x 2

Rat eradication trial

Brodifacoum 25W bait 1051kg
PPE for 16 staff – vests, glove, hard hats
PVC pipe and end caps to make baiting cups
RTK surveying equipment
Flagging tape, pink and blue
Pin flags, pink and blue
GPS unit x 4
Radios
Compasses and tape measures (back-up in case RTK fails)
Machetes x 8
Notebooks and pencils
10-person first aid kit x 2
Bleed-control kit

Feral cat tool trial

Victor 1.5 leghold traps x 30
Buckets x 30 (from rat eradication)
Steel trace, shark clips, washers
Cord
Hammer x 2
Sausages
Trail cameras x 15

Section 2 - Eradication of Kimoa/rats, feral pigs and feral cats

The operational plan for an eradication attempt is ordinarily developed during the planning phase of an operation. The planning phase for the Tokelau invasive mammal eradication has not yet begun as a decision as to whether to proceed with the eradication needs to be made once the Taupulega have had the opportunity to review the Feasibility report. The operational plan presented below is therefore a template that is intended as a living document, to be populated and shaped as results of eradication trials, innovation developments (e.g. heavy-lift drones) and feedback from community leaders. The methodology sections for each species will be developed as decisions are made during the planning phase. Sections including logistics, non-target species, environmental effects, safety of staff and community members and biosecurity will also need to be added as planning proceeds. For now, the detail under those headings in Section 1 can be used as a guideline.

Table 6 - Tools proposed for eradication on invasive mammals in Tokelau.

Species	Technique	Tool	Notes
Rats	Aerial Baiting	Drone with spreader bucket	Electric or petrol. Range of size from 50kg to 10 kg payload
Rats	Ground Baiting	20x20 metre grid cut and marked by ground team, bait hand-spread	Range of tools for marking grid from traditional compass to RTK system
Rats	Ground Baiting	Bait stations	For use in and around buildings
Feral pigs	Ground Hunting	Baited ambush hunting using rifle with thermal scope.	Requires 2 trained shooters
Feral pigs	Trapping	Pig brig and/or cage traps	
Feral pigs	Trapping	Snares	
Feral pigs	Ground Baiting	Sodium nitrite or similar toxic bait	In crab-proof bait stations
Feral pigs	Ground Hunting	Detection dogs	Team of trained dogs with 2 handlers
Feral cats	Aerial Baiting	Brodifacoum poisoning through consumption of poisoned rats	<i>Dependent on rat eradication</i>
Feral cats	Ground Baiting	PAPP or 1080 sausage	
Feral cats	Trapping	Victor 1.5 leghold traps	
Feral cats	Shooting	Baited ambush hunting using rifle with thermal scope.	
Feral cats	Detection/hunting	Detection dogs	Trained dogs with 2 handlers
All species	Detection	Trail cameras	Thermal or infra-red. Coupled with AI for image recognition.

KIMOA/RATS

A mixed model is proposed using ground-based broadcast of rodenticide bait to eradicate rats from the smaller islets and aerial broadcast by drone to eradicate rats from the larger islets. Table 7 below summarizes the ground and aerial treatment zones for each Nuku. Maps in appendix show proposed ground and aerial treatment zones.

Methodology

Ground-based broadcast will follow the methodology described in Section 1 above.

Aerial broadcast will be carried out by a drone with a bait hopper underslung. The drone would either be battery powered or a petrol/battery hybrid. Payload could be as low as 10kg per flight (current technology) or as high as 40+kg (near future). This technology is developing rapidly and at least four companies are working on platforms that may extend the capabilities of bait broadcast by drone. The drone would ideally be loaded from a barge on the lagoon, minimizing ferry time between baiting and re-filling the hopper. Bait will be spread in 70 metre swaths with a 50% overlap to eliminate gaps in bait coverage. An extra application of bait will be made around the coast using a deflector bucket to throw bait inland up to 35 metres, minimizing bait being dropped into the sea or onto beaches. Figure 6 illustrates the aerial baiting strategy for each motu.

GIS mapping will be used throughout the aerial operation to monitor for gaps in coverage and estimate the actual bait density applied to the motu.

The aerial broadcast work will likely be contracted out to an experience drone operator with a proven track record of completing aerial bait broadcast for rodent eradication.

Table 7 – Ground and aerial treatment zones summarized by Nuku.

Atafu - ground	96.1		20-person team	25 days
Atafu - aerial	185.6		Drone, 10 kg payload	30 days
Nukunonu - ground	138.0		20-person team	28 days
Nukunonu - aerial	181.0		Drone, 10 kg payload	30 days
Fakaofu - ground	118.9		20-person team	24 days
Fakaofu - aerial	176.7		Drone, 10 kg payload	30 days

Bait stations

Within the villages bait will be contained in locked bait stations to prevent young children and domestic animals from accessing bait. Bait stations will be placed around and under houses, and inside sheds and outbuildings, and at fales on the motu. Large cereal blocks, (containing the same formulation of brodifacoum as used in the cereal pellets), are staked in place to prevent rats removing bait from the stations. Bait stations will be checked on a regular schedule and bait replaced as needed; a register of bait stations will be maintained to track data for each bait station.

On Fale rats live in the sea walls that surround the village. Wodzicki trialled aluminium tubes as bait stations to target these wall-dwelling rats whilst excluding crabs from taking the bait. Treatment of wall-dwelling rats will need to be considered further during operational planning.

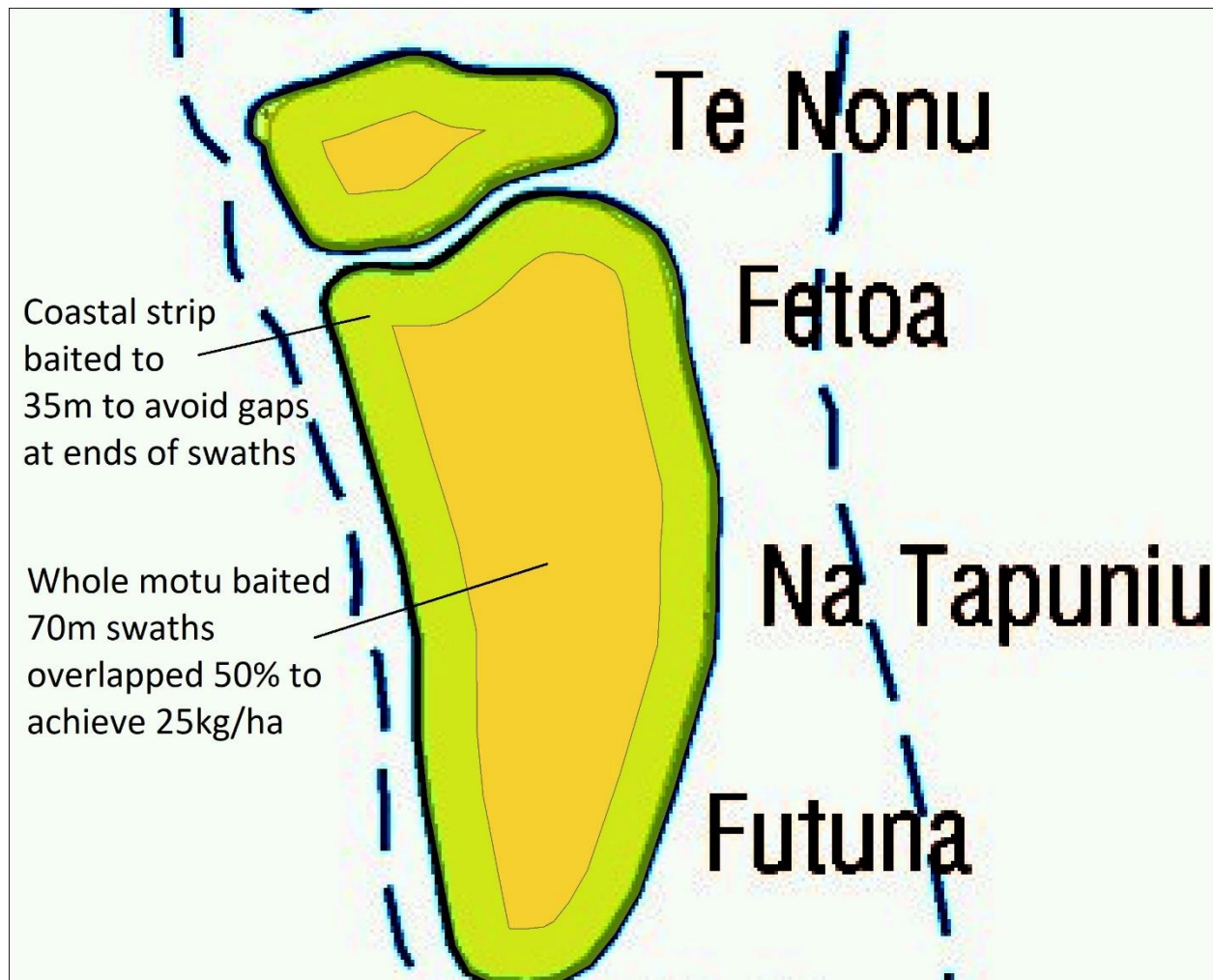


Figure 6 – aerial bait broadcast strategy for each motu.

FERAL PIGS

Feral pigs are intelligent and wary animals that learn quickly and adapt their behaviour when threatened. To achieve eradication a suite of tools will be used in sequence, beginning with passive tools that create little disturbance to individuals not directly targeted, ensuring that survivors remain naïve, and concluding with more aggressive tools to hunt down and destroy the last individuals. Independently, each tool will not remove the whole population but collectively the sequence of tools is designed to put every individual at risk.

The suite of tools chosen to eradicate feral pigs will depend on the results of the trials proposed in Section 1. Tools considered suitable in the feasibility report are detailed in Table 6. A team of trained pig dogs with at least two handlers will likely be required for mop-up work, particularly on the large island of Fenua loa. Experienced contractors are available in New Zealand.

Trail cameras will be used throughout to monitor pig populations to help managers decide adaptively which tools should be used where to target individuals or groups of animals.

FERAL CATS

As for pigs, a suite of tools in sequence starting with the most passive and finishing with more aggressive tools to hunt down the last survivors, will be required to eradicate feral cats. Tools considered suitable in the feasibility report are detailed in Table 6.

Secondary poisoning through consumption of live and dead rats that have consumed brodifacoum-laced rat bait broadcast for the rat eradication would be the primary tool for initial reduction of the feral cat population on Tokelau.

The scale of the population reduction (or “knock-down”) from this tool is impossible to estimate as it is influenced by factors that will vary significantly between motu e.g. the population size of rats. Feral cats are commonly killed through secondary poisoning by brodifacoum spread during aerial operations targeting rodents, and, under ideal conditions, kills of 80% or more can be expected for cats (Dept. Conservation 2021).

The scale of the population knock-down on Tokelau would be estimated using cat detections on a grid of trail cameras established prior to the rat baiting. Trail cameras will continue to be used throughout to monitor cat populations to help managers decide adaptively which tools should be used where to target individuals or groups of animals.

TIMELINE

Sequence of target species

below details the proposed sequence for eradication of each target species. Where feral pigs are present, (Nukunonu), they must be removed prior to eradicating rats. Pigs will certainly consume the rat bait in large quantities, and this creates risk of failure of the rat eradication by locally disrupting the availability of baits to rats (Dept. Conservation 2021).

The rat and feral cat eradications will begin at the same time, as the primary tool for eliminating feral cats is secondary poisoning caused by cats consuming rats that have consumed brodifacoum. The “mop-up” phase of the cat eradication continues beyond the end of the rat baiting as the last remaining cats are searched for using a grid of trail cameras and eliminated using a suite of tools. This coincides with the validation phase of the rat eradication, and the same grid of trail cameras will be used to search for any remaining rats, alongside other monitoring tools.

Sequence of Nuku

Because the three Nuku of Tokelau lie relatively distant from one another, eradication operations can proceed independently, provided that biosecurity measures are strictly observed for movements between the Nuku, to prevent reintroduction of invasive mammals. Rather than running operations concurrently on each Nuku it could be more efficient and economically sound to complete eradication on one Nuku before transferring resources (including some trained staff) to the next. This would allow for lessons learned to be adopted as the eradication effort progressed across Tokelau. The feral pig population would need to be addressed on Nukunonu prior to a rat eradication, and this could be done whilst the rat and cat eradication were being undertaken on Atafu or Fakaofu.

Table 8 – Proposed sequence of eradication of invasive mammals

Target species	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
Feral Pig	Pre-eradication population monitoring using baited trail cameras	Targeted removal of pigs using passive tools	Mop-up of remaining pigs using ground hunting with dogs	Validation of eradication using baited trail cameras			
Pacific rat					Aerial and ground baiting with approx. 50kg/ha Conservation bait 25ppm Brodifacoum. Baiting around and under buildings using bait stations	Validation of rat eradication using trail cameras, chew cards, tracking tunnels (and possibly eDNA testing after a year or more).	
Feral cat					Knock-down of cats using secondary poisoning through consumption of poisoned rats	Mop-up of cats using passive tools, remaining cats detected using camera network	Validation of cat eradication using baited trail cameras

DATA MANAGEMENT

A large amount of data will be generated by the eradication, including spatial data, trail camera images and monitoring data. Protocols will be established for processing and storage of data during operational planning. A Data Management position will be established for each Nuku to lead this work.

MONITORING

Pre- and post-eradication outcome monitoring of a variety of “indicator” species and taxa would be used to measure changes in biodiversity values. This work could be done by local staff trained by specialist monitoring staff, e.g. from Island Conservations Impact Monitoring Team. Table 9 below summarises possible biodiversity outcome monitoring measures based on previous eradications.

Table 9 - proposed biodiversity outcome monitoring measures

Species/Taxa	Sampling method	Location
Pacific Pigeon	Line transects	Roads through forest on Fenua Fala, Nukunonu village and Atafu village
Seabird nesting	Nesting seabirds (15m plot)	Random selection of motu
Seabird nesting	Count of nesting seabirds (circumnavigation of perimeter of motu)	Random selection of motu
Sooty Tern	Number and size of colonies	At tern colonies
Brown Booby	Total counts	Boat surveys across lagoon
Turtles	Track counts	Walk sandy beaches
Coconut	Coconut seedling/sapling counts	Motu with feral pigs e.g. Te Kamu and Te Puka I Muli, Nukunonu
Vegetation cover	Photographs in 4 cardinal directions and ground cover	Random selection of motu
Vegetation cover	Vegetation description	Random selection of motu
Skinks	Strip transect (400m x 1m)	Random selection of motu
Landcrabs	Strip transect (400m x 1m)	Random selection of motu, include motu with feral pigs
Marine	Coral & fish transects	Outer reef

Appendices

Appendix 1 – Step-by-step methodology for completing ground-based rat eradication.

1. Establish a grid across the project site.
 - Set up one Emlid RTK unit as the base unit on a known base coordinate
 - The remaining 3 units will be “rovers” carried and commanded by team members
 - Team members navigate to points on a pre-generated grid using a pre-programmed project on a mobile GIS application (Mergin maps)
 - Points are flagged with two pieces of flagging tape
 - Vegetation will be trimmed using a machete to allow access to points where necessary



Figure 7 – Mergin maps mobile data collection and navigation project being used with an RTK rover pole to establish a baiting grid on Palmerston Atoll, Cook Islands (left). An Emlid RTK unit set-up as a base RTK unit on Palmerston Atoll, Cook Islands. Images and information courtesy of Department of Conservation, New Zealand.

2. Hand-lay bait – inland broadcast
 - The weather forecast will be checked by the Technical Lead prior to each day of baiting. Baiting will continue unless a sustained period of rain is forecast when baiting will be temporarily suspended to preserve bait palatability.
 - Teams of two will undertake the baiting, one to throw bait and one to carry extra bait buckets. Bait will be carried in plastic buckets.
 - Where possible baiting will be carried out across discrete islets in one day. If this is not possible and bait application extends over multiple days, before recommencing bait will be reapplied along the adjacent three lines to create a buffer.
 - At each grid point bait should be spread out to about ten metres. 1000 grams of bait are to be thrown at each point. Calibrated bait scoops will enable accurate measurement. A fifth of the

bait (200 g) should be thrown in each quarter - North, East, South and West—and the last around the baiter's feet as shown in figure 7. The only exceptions to this will be grid points on the coast or at the edge of the baiting grid. Bait should only be applied above the high tide mark.

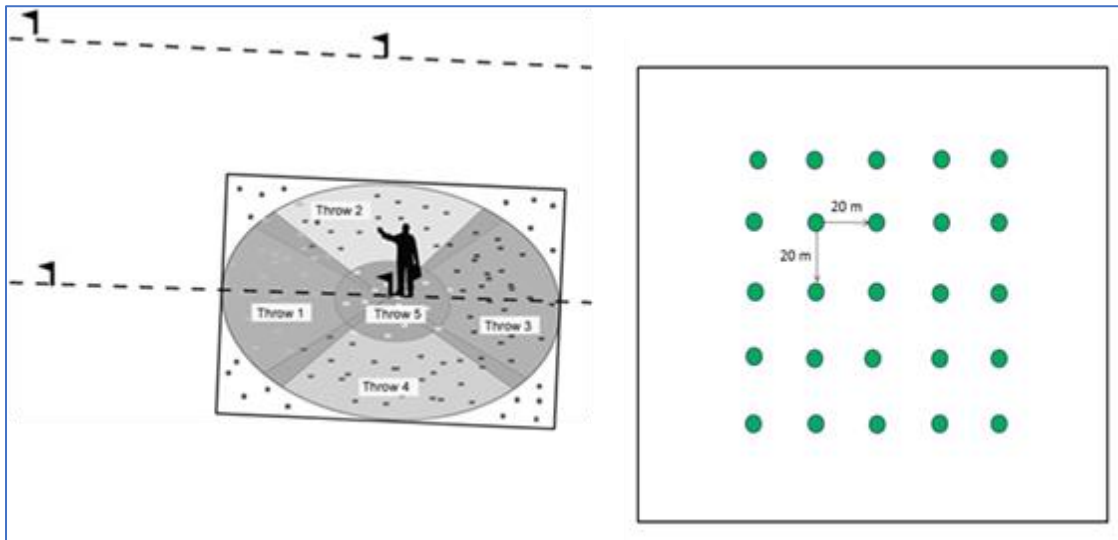
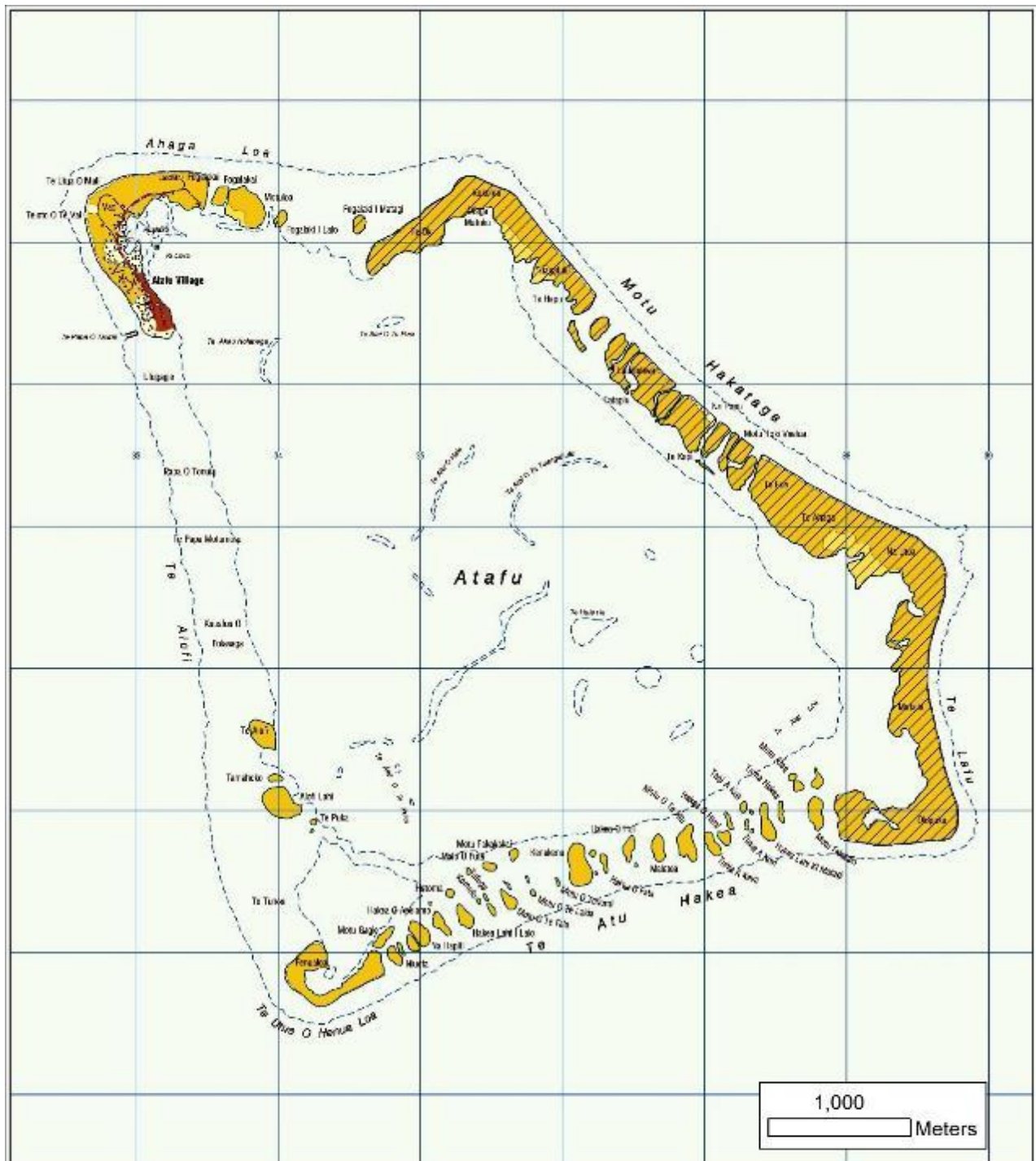


Figure 8 – Diagram of handlaying rodent bait on a 20x20 metre grid

- Bait usage will be tracked throughout the operation by dividing the amount of bait used by the hectares of each islet completed.
- More bait will be applied to areas that may pose a higher risk of failure. These will include areas that have high numbers of non-target bait consumers, such as hermit or land crabs (see crab section below), areas of human activity, or areas where alternative food is more abundant.
- Bait will be placed in bait stations inside and under any enclosed buildings and structures (including roof spaces) where rodent movement is possible. Bait stations will be maintained and monitored throughout the operation.
- 25 pellets will be placed in each bait station, deployed on the first day of baiting the respective motu. Stations will be checked initially daily and then weekly after the first week. Bait take will be recorded into the monitoring spreadsheet and bait will be topped up to total 25 pellets.
- A second application of bait will be undertaken following an interval of at least 18-21 days (allowing any young rodents to emerge from nests), using the same specifications as the first application.
- Once the second bait application is completed, all flagging tape and packaging will be recovered and disposed of along with any unused bait in accordance with the manufacturer's recommendations.

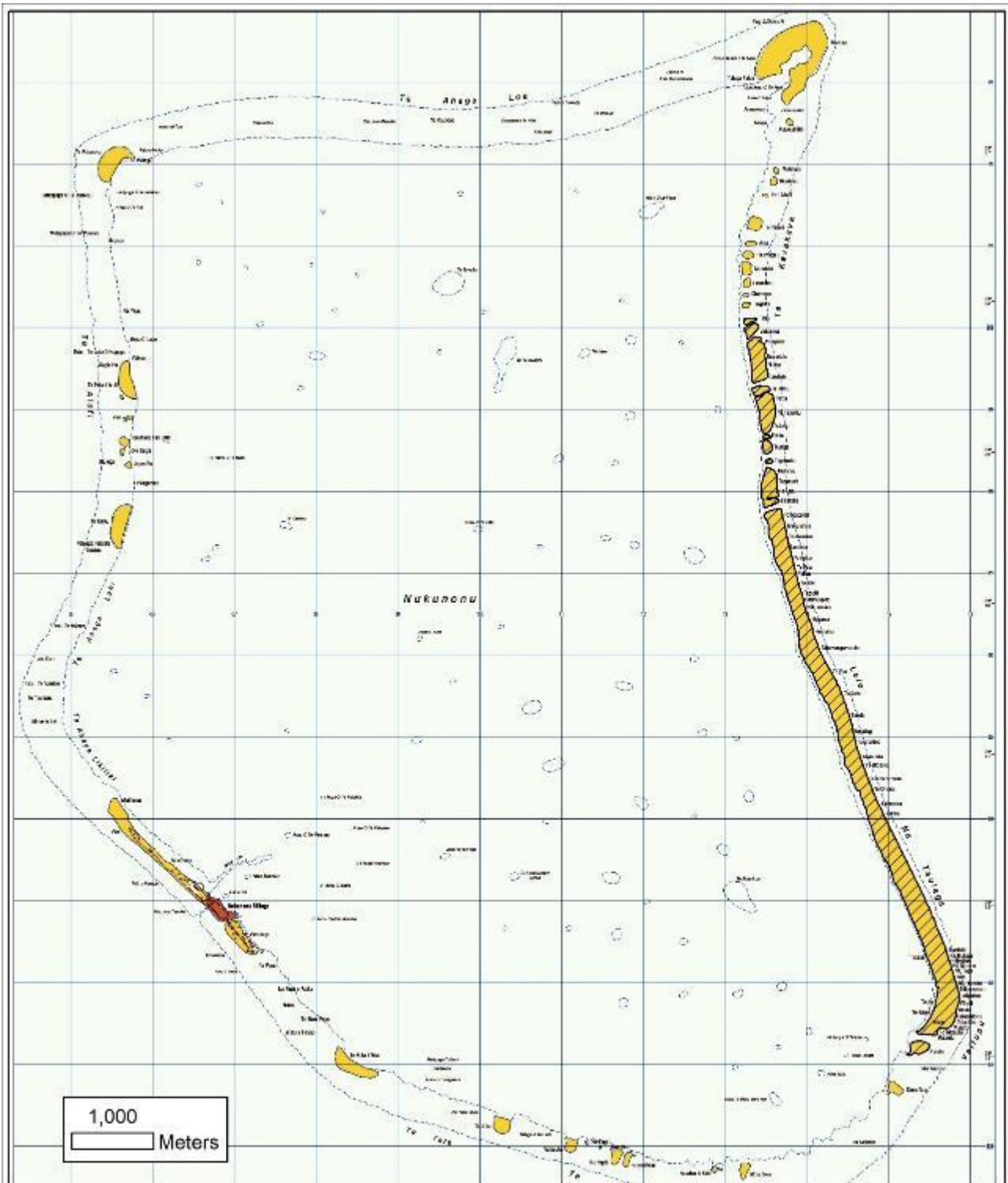
Appendix 2: Maps



Atafu proposed treatment zones

Black hatched area = aerial broadcast treatment zone, 185.6 ha

Un-hatched area = ground broadcast treatment zone, 96.1 ha



Nukunonu proposed treatment zones

Black hatched area = aerial broadcast treatment zone, 181.0 ha

Un-hatched area = ground broadcast treatment zone, 137.95 ha

