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MINISTRY OF AGRICULTURE
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Operation report on the field delivery period: Palmerston Atoll rat eradication project, August – September 2023

Author: Em Oyston (Department of Conservation)
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1. Introduction

This document reports on the operational activities carried out over the field work delivery period of the Palmerston Atoll rat eradication. The purpose of doing this is to retain and build institutional knowledge and learnings for future operations; as well as report on the operational proceedings in the event they need to be referred to in the future.

The operational delivery of the eradication was carried out in August and September 2023, with eradication validation monitoring anticipated to occur in March 2024. The project was funded by the New Zealand Ministry of Foreign Affairs and Trade through the Managing Invasive Species for Climate Change Adaptation in the Pacific (MISCCAP) programme. The planning and operational delivery of the eradication project was led by the New Zealand Department of Conservation (DOC), with collaboration and support for fieldwork provided by the Cook Islands' National Environment Service, Te Ipukarea Society (a Cook Island non-governmental organisation), and the Palmerston Island community.

The 6 months' worth of operational planning for the project is detailed in the Palmerston Atoll Operational Plan (Oyston, 2023), and a feasibility study (Oyston, 2023a) was carried out prior to this in November 2022. The operational plan should be used for reference in conjunction with this document if the reader is unfamiliar with the site and project context.

1.1 Project context

Planning and logistical preparations for the project took place in New Zealand, Rarotonga, and Palmerston Atoll between February and June 2023. The delivery phase of the eradication took place on over a six week period (not inclusive of travel) in August-September 2023.

The project has several phases as outlined below; this document reports on phase 3 only:

1. Feasibility study (completed January 2023)
2. Operational planning (February – June)
3. Field delivery – grid construction, bait application, and establishing biosecurity infrastructure (August - September)
4. Post operation monitoring and confirmation of outcomes (March 2024)
5. Project debrief (April 2024)

Phase 1 confirmed that kiore (*Rattus exulans*) were present on only two islands of Palmerston Atoll – Home Island (inhabited with a population fluctuating between 30-60 people) and Cooks motu (uninhabited). Ship rats (*R. rattus*) were also present on Home Island. Therefore the scope of the eradication included only these two islands for the hand broadcast application of toxic baits, however, ensuring rats did not establish on other motus in the Atoll was also critical to the project's success.

A full background context on the social and environmental contexts of Palmerston Atoll can be found in section 2 of the Palmerston Atoll Operational Plan (Oyston, 2023). An overview of the operation itself is provided in **Table 1.1 below.**

Table 1.1: Operation overview

Location	Home Island (36ha) and Cooks Motu (29ha) – two islet groups located in Palmerston Atoll, Cook Islands. Palmerston Atoll is located approximately 500km northwest of Rarotonga.
Target species	*Rattus rattus* (Home Island only) and *Rattus exulans* (both Home Island and Cooks Motu)
Timing	Winter 2023 (August – September 2023)
Deliverables	• Supporting the community in management of alternative food sources for rats to reduce risk of eradication failure • Teaching community members eradication, monitoring and biosecurity field skills and tool use • Constructing a 20 by 20 m grid of marked points for hand broadcast toxic bait distribution • Establishing and monitoring bait trays across potential home ranges within every building • Establishing biosecurity infrastructure and procedures • Applyingtoxic bait • Bait availability monitoring • Maintaining safety and wellbeing of field team members

Target benefit species	Humans, coconut crabs, green turtles, and a range of ground-nesting seabirds	
Vegetation type	Coconut palms, tropic wooded forests dominated by pandanus and Pacific mahogany, exposed coastal vegetation such as *Pemphis* sp.	
Project Manager	Em Oyston (DOC)	
Lead organisation	New Zealand Department of Conservation	
Collaborating organisations	Te Ipukarea Society, Palmerston Island Administration and community, National Environment Service, Ministry of Agriculture (all Cook Islands organisations)	
Methodology	Hand broadcast application of Pestoff Rodent Bait 20R® (containing 20 parts per million brodifacoum) over three separate applications across a 20 x 20 metre grid. Three applications spaced over 18 days. Interior and any enclosed roof spaces of buildings baited with open bait trays, which were monitored every 3-5 days for 35 days.	
Baiting rates (average rate across broadcast grids)	Home Island- first application 21kg/ha second application 16 kg/ha third application 12.5 kg/ha	Cooks Motu – first application 33.5 kg/ha second application 34 kg/ha third application 13.5 kg/ha

1.2 Objectives of the field delivery phase of the project

The key objectives of the field delivery phase of this project were:

- Ensure previously-identified risks were satisfactorily managed by the community, and if not – assist the community in managing these issues prior to bait application
- Establish a 20 by 20 metre marked and cut grid across the entire treatment area to allow comprehensive and consistent bait coverage through hand-broadcasting
- Create and implement a building baiting plan for the many buildings and infrastructure located on Home Island
- Apply toxic bait across the operation area using the broadcast grid and building bait trays, so that palatable bait would be available to every rodent for a minimum of 21 days
- Monitor bait availability to ensure application rates are enough to ensure bait availability
- Establish biosecurity infrastructure and processes to support the sustainability of the rat eradication

Section 2 of this report provides details on how the delivery of tasks to meet these objectives went, and any lessons learnt that could benefit future eradication projects.

2. Narrative of fieldwork methods, delivery, and outcomes

2.1 Community-led management of previously identified-issues

As per section 3.2 of the operational plan (Oyston, 2023), there was an agreed plan of action to address a number of previously identified risks (mainly regarding alternative food sources for rats) for the Palmerston Island community to address prior, during, and after the eradication. This section summarises the management of these actions.

2.1.1 Disposal of agricultural crops and produce (Home Island)

The majority of rodent-palatable agricultural and horticultural alternative food sources were harvested prior to the field team arriving. During the first fortnight, the field team identified some food sources which had been missed or were not being managed (e.g. remnant guava, star fruit, and sugarcane) and these were removed prior to the first application of bait. Coconuts and pandanus fruits were not managed due to it not being practical in terms of scale and accessibility.

Breadfruit continued to ripen during the bait application period and fallen fruit was often found on the ground. The PIA were requested to employ James Frisbee (local school student) to do a daily check and collection of fallen breadfruit until the second week of October to minimise the potential risk of this food source.

Collected fruit were put in sealed plastic buckets, then disposed of by being taken off island to be fed to penned livestock being held temporarily on rat-free islets. .

Figure 2.1.1: *Removal of sugar cane crops (left) and star-fruit (right) as part of reducing alternative food sources for rats*

2.1.2 Removal of pigs (Home Island)

Prior to the field teams' arrival, 14 of the 17 domesticated pigs on Home Island were culled prior to the field delivery phase of the project, due to the risk of uneaten pig food and/or pig faeces being an alternative food source for rats. The three remaining pigs (owned by Eddie Marsters) were transported to Primrose motu where they were appropriately penned and fed and watered every other day. Domesticated pigs that were culled will be replaced at the cost of the project – this will be facilitated and led by the Cook Islands Ministry of Agriculture (MOA), with stock to arrive after full degradation of monitored toxic baits and rat carcasses. The pigs from Primrose may return to Home Island one month after the final bait application provided they are contained within a pen approved by Island Administration, and which has had any remnant of toxic bait removed, and until bait and carcass monitoring has

shown complete degradation.

Figure 2.1.2: *Pig and chicken pens on Primrose motu*

2.1.3 Removal of chickens (Home Island)

Prior to the field team's arrival, the Palmerston community put significant effort into reducing the domesticated and wild chicken populations on Home Island. Domesticated chickens were culled, with the exception of two households (Bob Marsters and Eddie Marsters) where chickens were moved to a small islet to free range (Kitsap sandbank) and penned on Primrose respectively. As for the pigs, these were fed and watered every other day.

By August 2023, both domesticated and wild chicken numbers were significantly reduced relative to what was observed in November 2022 during the feasibility study fieldwork (likely 100-200 individuals originally). The few remaining chickens were extremely wary; ad hoc effort by the community and field team to cull individuals continued up until the first baiting period . Methods included hand-catching, cage/box traps, snare traps, and shooting. It was noted that a sighted .22 with a scope would have been extremely useful and effective for culling the last chickens, but administrative barriers within the Cook Islands paired with timeframes prevented this.

At a conservative estimate, no more than 20 chickens remained at the time of the first bait application. This was reduced further after bait from the first application had softened with rain/humidity; dead chickens were found, thought likely to have died from eating softened toxic baits. Only one known chicken remained by the time the field team departed.

As for pigs, breeding stock of chickens will be replaced at the cost of the project – this will be facilitated and led by MOA, with stock to arrive after full degradation of monitored toxic baits and rat carcasses. The chickens housed on Kitsap and Primrose may return to Home Island one month post-the last bait application provided they are contained within a pen approved by Island Administration, and which has had any remnant of toxic bait removed. Once bait and carcass monitoring have shown full degradation, free-ranging chicken husbandry will be allowed again if desired by the community.

2.1.4 Containment of grey/black water systems (Home Island)

The community had successfully addressed containment of black and greywater systems in advance of the field delivery phase of the project, by installing sealed drum systems underground at all applicable residential dwellings. This prevented access to a potential food source to rats.

Figure 2.1.3: *Community members addressing containment of waste water from a residential building*

2.1.5 Burning off rubbish holes and coconut husk piles, and establishing a rubbish collection and consolidation system (Home Island)

By the field delivery period, the community had begun a rubbish containment and collection system, and consolidated rubbish disposal and burning to a single pit administered by the Island administration. In general, packaging/rubbish was limited. Each household was given sealed containers to put food waste and rubbish into; food waste was collected and delivered to pigs and chickens being homed on Primrose and Kitsap motu every other day, and rubbish was burnt by Island administration when quantities warranted it. Island administration collected food waste and rubbish containers, and provided replacement buckets on demand from households. Old piles of coconut husks had also been burnt to reduce potential rat habitat.

It was observed by field team members that uta (sprouting coconuts) had also been burnt, inadvertently creating a food source for rats (toasted coconut) that they would not otherwise have been able to access due to the husks' hardness. Fortunately, this had been done prior to the field team arriving so any toasted coconut made accessible had already been eaten before the baiting application period, and no further uta were burnt., In areas where old coconut husk piles had not been burnt, additional bait was distributed on and around these piles.

The community was advised to prolong the efforts of rubbish collection and consolidation until at least 6 weeks after bait had initially been accessible to rats. Old rubbish pits were burnt extra hot using accelerants and hot burning fuel prior to baiting days; and rubbish pits were additional baited as part of the first bait application.

Figure 2.1.4: *Island administration rubbish collection (left) and an example of burnt uta being a potential food source for rats (right)*

2.1.6 All stored food and food scraps contained and inaccessible to rodents (Home Island)

In general this was done well with most households being compliant. It was observed on multiple occasions that one household (Bob Marsters') was leaving food-waste present on the ground. The heads of this household were talked to on multiple occasions but the presence of alternative food sources was repeatedly noted. This issue was highlighted to the Executive Officer and other households (in order for the community to hold others to account), and it was raised in a village meeting by the field team. It reinforces the difficulties of enforcement of agreed rules for individual/s that are not compliant in a culture where enforcement of rules/laws is difficult. The project's approach was to work with the community to identify where compliance issues existed and encouraged pressure from the community and existing social structures to resolve these compliance issues.

The community was advised to prolong the efforts of collection of food scraps and containment of food until at least 6 weeks after bait had initially been accessible to rats.

Figure 2.1.5: *Typical residential rubbish and food waste collection system on Home Island during the eradication period*

2.1.7 All buildings accessible for baiting and clutter is reduced/cleared (Home Island)

Effort had been made by the community to reduce clutter in some buildings that were not occupied and used as storage. There were still a number of buildings where this had not occurred. Some of these areas of buildings bait was broadcast into, but most areas were within appropriate proximity to an established bait tray.

2.1.8 Pre-eradication monitoring to confirm absence of rats on rat-free motu

Lured trail cameras were established on the vegetated rat free islands in the month prior to the field delivery period to ensure these islands were still rat free and did not need to be considered in the scope of the eradication. North Islet, Karakarake, Primrose, and Toms motu had five trail cameras lured with toasted coconut flesh or peanut butter established for a week on each island, with cameras set to capture 10 second videos on motion detection.

No rats were detected by cameras during this period, nor was there any sign to indicate rats were present. This is in addition to the anecdotal evidence from the community's ongoing visits to the motu that rats had not established.

2.1.9 Biosecurity rules and processes set in place for receiving cargo on the atoll

Formal additional biosecurity procedures for incoming cargo had not been agreed upon by Island Administration or the community by the time of the field team's arrival. Discussions with the Executive Officer and the biosecurity officer resulted in the agreed process of:

- Biosecurity officer (Julianna Marsters) goes with small boats to vessels unloading incoming cargo from outside the reef
- High risk items are inspected. High risk is defined as any cargo not sealed sufficiently to prevent rodent access or that has cavities that rodents could get into. This cargo needs to be visually inspected by the Biosecurity Officer – either on the deck of the cargo vessel, or in the small boat – before it is landed on the beach at Home Island.
- Small boats must not land any cargo on the beach without the Biosecurity Officer having first identified that it is not a high-risk item.
- If an unwanted stowaway or risky contamination is found during inspection, the goods will be returned to the visiting vessel until the biosecurity officer is confident the risk has been managed (e.g. a stowaway rodent has been dispatched). If the risk cannot be managed adequately then contaminated goods will be sent back to their origin

This was shared with the community at an all of island meeting while the field team were present. The community are encouraged to continue sending goods in sealed decommissioned freezer units as is currently done, but it is acknowledged that some cargo cannot fit in these units and will need to be subject to the rules above. Raising awareness of stricter biosecurity procedures for families returning to Palmerston in the future is the responsibility of the Island Administration, Island Council, and community.

Figure 2.1.6: *Outgoing cargo from Rarotonga destined for Palmerston. Where possible, the majority of cargo goes in decommissioned ffuture isth lids sealed and shrink-wrapped, making an ideal rodent proof container*

2.2 Creation of ground baiting grid

A precise grid of 18.9 x 19 metres 19 by 19 metre grid was established over Home Island (consisting of 997 grid points) and Cooks motu (829 grid points). The grid was originally intended to be 20 x 20 metres but due to projection issues in the particular geographic zone, planning had allowed for 18.9 x 19 metres and a decision was made to stay with this layout due to it providing better spatial coverage rather than worse. The project trialled the use of Real-Time Kinematic (RTK) equipment and mobile GIS data collection applications to plan, navigate, and record and manage data related to the grid. This was highly successful and a more comprehensive description of the methodology and benefits can be found in Appendix 1.

Grids were established using teams of 3-4 people. A navigator with RTK equipment and mobile data collection system navigated to pre-planned grid points. Others in the team followed the navigator and cut vegetation between grid points on transects (for efficiency of travel and point relocation during baiting), and marked grid points using labelled flagging tape on standing vegetation or a placed pole. Using the mobile app, navigators confirmed grid point layout and entered associated metadata for each point as points were completed. Mobile app data was then synced by the teams at base usually at mid-day and the end of the day in order for the project manager and team leaders to track progress, do quality control, and plan and allocate the following day's work programme. The establishment of grid points and transects across both islands required approximately 40 kilometres of track cutting and marking.

Figure 2.2.1: *Aerial photograph of Calcutta (within Cooks motu operation block) with grid transect lines visible part way through completion*

Grid points were marked and labelled with a consistent system of transect ID followed by grid point number. Points on odd numbered transects were marked with orange flagging tape and even numbered transects were marked with pink flagging tape to aid navigation. A center line transect was made as a reference line though the middle of the grid, and these points were marked with blue flagging tape.

On Home Island, areas of the grid which had no rat habitat within a 19 metre square area (i.e. just bare sand such as the main road, volleyball court, and school playing field) were excluded from the grid, and grid points were located on the edge of these features, paired with a baiting protocol of not broadcasting bait into those areas.

The grid area on Cooks motu was reduced from 829 marked grid points during the first application, to 787 for the second and third application. The reduction of grid points was due to the points off the western edge of structural vegetation on Calcutta (middle island) being tidal so bait was being fully immersed in seawater during high tide.

See Appendix 2.1 and 2.2 for maps showing the final grid layouts on Home Island and Cooks motu.

2.3 Establishment of building baiting trays

Bait trays were used in buildings and covered areas to ensure every rat had access to bait over the operation period. 115 buildings were identified on Home Island, and 556 bait trays were established in rooms and underfloor and ceiling spaces of these buildings. This was refined to 546 trays after several checks due to some trays being considered redundant. There were 26 sites in buildings where bait was hand laid and not placed in trays (with the consent of building owners and/or occupiers), due to clutter in storage areas causing access issues, or some areas being hazardous to access. **Figure 2.3.2** shows the distribution of buildings, bait trays, and hand laid areas within buildings on Home Island.

Each of the 115 buildings was given a unique ID number as a planning reference. Bait trays used were biodegradable flat pack wooden poplar bowls. Each of the 556 bait trays had a unique ID (UID), consisting of a building's ID number followed by a different letter of the alphabet for each tray within that building. The unique ID was written on the tray with permanent marker (see **Figure 2.3.1**).

Building baiting (both bait trays and hand laying) sites were entered into a project geodatabase which stored and collated metadata for each individual bait tray (Building ID, bait tray UID, location description, date established, who established it, check dates and check persons, amount of bait present at each check, and additional notes such as evidence of non-target bait take). This geodatabase was part of the wider Palmerston project in the mobile Mergin Maps app (see Appendix 1 for details). This facilitated navigation to, and data collection/entry for, each bait tray.As for grid establishment, data collected by field team members was synced by the end of each day. This allowed the project manager and team leader to assess the status of bait tray layout, bait-take rates, identify risks (e.g. non-target bait take, human interference) and potential refinement opportunities, run quality control, and allow effective adaptive management in the workplan.

Figure 2.3.1: *Example of bait trays used with UID*

Figure 2.3.2: *Buildings, bait trays, and building hand laid sites on Home Island*

2.4 Toxic bait application

2.4.1 Application methodology

Cereal based rodenticide baits (Pestoff 20R®) were hand broadcast across the established bait grids, and placed in established bait trays established in buildings.

Hand broadcast baiting was done by dividing the operation block (Home Island or Cooks motu) into sub-blocks, which were allocated to individual field team members to bait. The day prior to bait application, sealed 10kg bait buckets were distributed and cached on the grid at strategic locations, in order for baiters to continuously bait their transects on baiting day without leaving their lines to get more bait. Fieldworkers then baited their allocated block by systematically following their bait transects and broadcasting bait at each grid point.

At each grid point bait was broadcast in set directions (e.g. 0, 90, 180, 270 degrees) with a throwing distance of 7-10 metres, and depending on the application, a number of shorter-range throws (see **Table 2.4.1** for more details). Commercial plastic scoops that had been cut to hold an exact known amount of bait were used to distribute exact amounts of bait from each grid point. When a grid point was baited, the time and person baiting that point was recorded in the field in the project's geodatabase in the mobile app (see Appendix 1). An additional broadcast application was done at unmarked 20 metre GPS guided spacings around each island's perimeter for the first and second applications of each operation block. It took a full day each to complete a hand broadcast application across the two grids on Home Island and Cooks motu.

Building bait trays were initially filled with 10 baits on each bait tray, then on subsequent checks trays were replenished as necessary to 10 baits. Building bait take was recorded in the field in the project's geodatabase on the mobile app (see Appendix 1).

Spot applications of bait (hand broadcasting of additional bait) occurred on Home Island in the four Puraka pits where bait was observed to be less available several days post-application, and in rubbish pits where high rat activity had been observed in the past (see notes in **Table 2.4.1** and figure **2.4.1**).

Figure 2.4.1: *Home Island showing the location of puraka pits (hatched white) and rubbish pits (yellow/red stars) that received additional spot broadcast baiting.*

2.4.2 *Application timing*

Three hand broadcast bait applications were carried out across the baiting grids on each of Home Island and Cooks Motu between August 28th and September 14th. The apacing between the first and second bait applications was 10 days for Home Island and 11 days for Cooks motu; the spacing between the second and third applications was 7 days for Home and 4 days for Cooks.

Dates of broadcast applications and application rates can be found in **Table 2.4.1**.

Table 2.4.1: Broadcast baiting and spot application details for Home Island and Cooks motu

Application	Date	Average application rate on grid	Notes
Home Island first application	28/8/23	21 kg/ha	Additional perimeter baiting around perimeter at 20m spacings . 4 x directional throws and two short '180' degree throws at each grid point
Cooks motu first application	29/8/23	33.7 kg/ha	Additional perimeter baiting around perimeter at 20m spacings. 4 x directional throws and one short '360' throw at each grid point.
Home Island spot application	30/8/23	Approximately 16 kg/ha	Additional bait spot broadcast in Puraka pits; 43 rubbish pits had additional baiting
Home Island second application	7/9/23	16.1 kg/ha	Additional perimeter baiting around perimeter at 20m spacings. 4 x directional throws and one short '360' throw at each grid point.
Cooks motu second application	9/9/23	33.8 kg/ha	Additional perimeter baiting around perimeter at 20m spacings. 4 x directional throws and one short '360' throw at each grid point.
Cooks motu third application	14/9/23	13.6 kg/ha	No additional perimeter baiting done. 4 x directional throws at each grid point.
Home Island third application	13/9/23	12.7 kg/ha	No additional perimeter baiting done. 4 x directional throws at each grid point.

In conjunction with the broadcast baiting on the grids, building/infrastructure baiting on Home Island occurred on the 26th of August. Bait trays were then servicedevery 2 – 5 days until the 25th of September as per **Table 2.4.2** below. Appendices 3 and 4 contain a more detailed diary of broadcast and building baiting.

Table 2.4.2: Building bait tray servicing details for Home Island

Check number	Dates	Notes
Initial application	26/8/23	
first service	28/8/23	
second service	30/8/23	
third service	2/9/23	
4th service	6/9/23	
5th service	11/9/23	
6th service	18/9/23	Only 34 trays checked (only check trays that had any consumption on the prior two checks)
7th service	24-25/9/23	Awaiting data from on-island still
Trays disestablished	est. 30/10/23	TBC

2.4.3 *Bait used*

PestOff 20R® bait (a 2 gram cereal bait containing 0.002% of the second generation anticoagulant brodifacoum) was used for the operation. A total of six tonnes of PestOff 20R® was transported to Palmerston, with bait being manufactured in late April, and arriving for secure storage on Palmerston by late June. Specific care was taken during the full supply chain that the pails holding bait were not exposed to direct sunlight, or significant fluctuations in temperature; bait was transported from production to Palmerston in the shortest timeframe possible.

On the field team's arrival, the bait was inspected. It was observed that a significant amount of the bait had various stages of mould developing. 201 out of 600 pails had various stages of mould developing (88 pails had light moulding, while 113 had more advanced moulding). As the total quantity of bait procured included significant amounts

(approximately 30%) of contingency bait, both the first and second applications of bait on the baiting grids used bait that did not have visible mould on it. Based on visual inspection, the best quality bait was prioritised for the first grid application and building baiting, then the second grid application. A small amount of bait (less than 100 kg) that was used for the perimeter baiting on the second application on Cooks motu and the third grid application on Cooks motu had very minor visual mould present. Excess/spoiled bait disposal is covered in Section 2.7.

Figure 2.4.2: *Example of bait in one of the more badly mould-affected bait pails when unsealed on 22/8/23*

2.4.4 Climatic variables during baiting

Figure 2.4.3 summarises the measured climatic variables during the field delivery period. Preceding weather conditions for the three weeks prior to the first bait application were dry and windy, with a total of 12mm of rain between 9/8/23 and 24/8/23. 67mm of rain then fell in the three days before the first bait application on Home Island. The first period of bait being available to rats following the first broadcast application, between the 28th of August and 7th of September, was dry with low relative humidity (average 70% RH) by Palmerston standards, and average temperatures of 25 degrees Celsius.

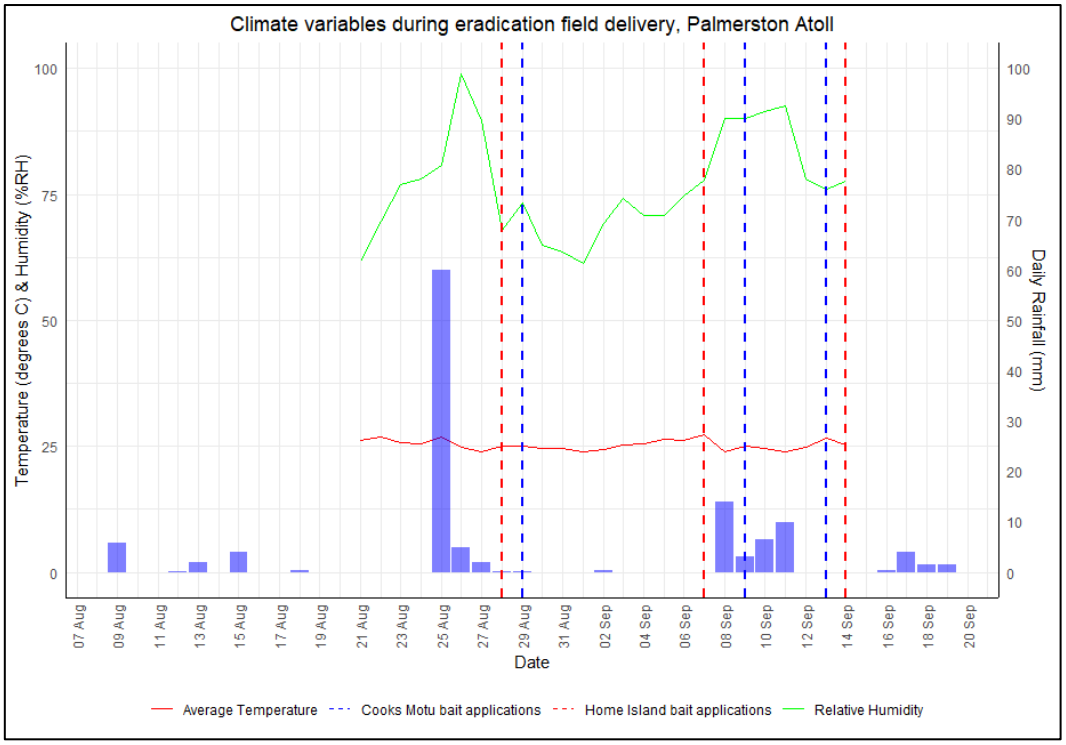


Figure 2.4.3: *Climate variables during the field delivery period on Palmerston Atoll. Dashed lines indicate the hand broadcast bait application days on the baiting grids. Variables were measure with loggers on Home Island*

The weather during and after the second bait application was less consistent and potentially sub-optimal due to cumulative rainfall (approximately 35mm) following the bait application. The observations of bait degradation due to this weather prompted the decision to carry out an extra third application of bait, to ensure palatable bait was available for a full 21 days to ensure any new born rats emerging would have access to and want to consume bait. Less than 10mm of rain fell in the 9 days following the third bait application.

Application dates were based around avoiding predicted significant rainfall events, but weather forecasting (using various models on Predictwind.com and Windy.com) was unreliable; what eventuated was routinely inconsistent with the forecast.

2.4.5 Environmental variables and observations

Confirmation that the rat population was breeding during the field delivery period was obtained through catching approximately 20 rats (kiore) on Home Island prior to the first bait application. Several lactating females were caught, and recently born (unfurred) pups were found near recently trapped females.

Coconut palms and Pandanus trees are prevalent on both Islands, and both had fruit/nuts present at various lifecycle stages. Prior to the first bait application, what was thought to be kiore were also seen feeding on the flowers/pollen of coconut palms in the canopy (see figure 2.4.3). On Home Island horticultural fruit was harvested in advance, but breadfruit and guavas continued to ripen and drop through the application period, which was mitigated by collection of fallen fruit at known sites almost daily.

Figure 2.4.3: *Kiore observed in the canopy of coconut palms, feeding of flowers.*

There were many observations by the field team and community of either dead rats, or rats in a lethargic/near death state following the first bait application. One live rat was seen climbing a coconut tree near Bob Marsters place after the second application (pers. comms Bob Marsters and Tikaroa Marsters), and a young juvenile was heard and seen in the roof space of Tikaroa Marsters house after the second application (pers. comms Tikaroa Marsters).

During the second application on Cooks one baby (furred) rat was seen re-entering a burrow on the southwest side of Aparanuta (southern islet of Cooks).

The team's response to the live rats seen after the first baiting application was to ensure palatable bait was adequately present and available in the area of the sighting, which it was in all three instances.

2.5 Bait availability monitoring

Bait availability monitoring plots were used to determine if bait application rates needed to be adjusted for subsequent bait applications, and to provide bait availability data for retrospective project review.

2.5.1 Methodology and monitoring design

Bait availability monitoring was run in each operation block for the first and second hand broadcast bait applications. The monitoring consisted of twenty 25m^2 (1m x 25m) transect plots in each operation block, distributed across broadly stratified habitats that were perceived to potentially influence non-target bait consumption (see Table 2.5.1). Plots were monitored for 5 consecutive days (4 nights of bait availability) starting from the day of each bait application. The number of baits present in each plot were counted within hours of bait being broadcast in that plot, and marker flags were placed next to each bait. Subsequent day counts involved checking all marker flags and removing any flags where bait was no longer present, then tallying the plot count based on number of flags removed. Data was recorded in the project's geodatabase on the mobile app (see Appendix 1), allowing data to be synced and run through a preprogrammed R script each evening to allow a quick and easy assessment of bait availability each night.

Due to a shortage of time on the baiting/plot construction day , three plots were not established/measured during the second application period on Cooks (plot n=17).

Table 2.5.1: *Number of bait availability plots by habitat*

Operation block	Habitat stratification	Plots monitored in first application	Plots monitored in second application
Home Island	Chicken foraging sites	5	5
	Residential	5	5
	Open/tall forest	5	5
	Coastal	5	5
Cooks motu	Land crab/tupa areas	7	7
	Open/tall forest	7	5
	Coastal	6	5

Locations of monitoring plots are shown in **Figures 2.5.1** and **2.5.2**.

Figure 2.5.1: *Location of bait availability monitoring plots and bait and carcass degradation plots on Home Island (prefix of labels indicates habitat – HCO = Coastal plot, HT=Tall/Open forest plot, HR=Residential plot, and HCH=Chicken foraging plot*

Figure 2.5.2: *Location of bait availability monitoring plots on Cooks motu (prefix of labels indicates habitat – CCO = Coastal plot, CT=Tall/Open forest plot, CCR=Crab burrow plot*

2.5.2 Bait availability plot results and discussion

Figures 2.5.4 to 2.5.8 show the results of bait availability monitoring across both operation blocks for the first and second broadcast bait applications. In general, bait availability was as expected based on similar monitoring run in November 2022 during the feasibility study.

Based on plot measurements, bait never appeared to come close to being completely depleted in any plots by day 5 (night 4) (see Figures 2.5.4 and 2.5.5). Paired with informal observations of bait presence in the operational areas, this gave confidence that bait was available to rats for the best practice standard of a minimum of 3 nights after each application. Given the relatively small level of bait-take, the relatively high quantity of bait remaining in Home Island plots, and the climatic conditions causing bait to remain present and in excellent condition ten days after the first bait application, it was decided to make a slight reduction in the application rate for the subsequent applications on Home Island. As Home Island was inhabited, where there was sound justification for using less toxin then this was done. This decision also meant that when a third application was made, good quality bait could be used.

Figure 2.5.3: *Land crab/tupa (left) and hermit crab (right) consuming bait*

Bait availability monitoring showed a slight initial decline on Home Island over the first 2 days following the first application, particularly in tall forest, sites with known chicken presence, and residential sites , but then flat-lined for the remaining period and second application (see Figure 2.5.6). On Cooks, bait availability declined more sharply and consistently following both bait applications – particularly in areas heavily burrowed/occupied by tupa/land crabs. This was anticipated given the presence on Cooks of land crabs and coconut crabs that were expected to consume bait, and this was anticipatorily managed through higher bait application rates for the Cooks operation block.

King tides flooded a number of coastal and land crab bait availability plots on Cooks during the first application's monitoring period, which resulted in baits disintegrating/disappearing in those plots, reflecting reduced bait availability in that coastal area. Figure 2.5.8 illustrates the relatively low bait take on Home Island, due to it having a lower density of non-target bait consumers than Cooks motu.

Bait availability was significantly higher in the second application period of monitoring due to baits from the firstfirst application still being present, resulting in a higher bait density than the application rate of the second application. Bait availability monitoring could not be conducted on Day 2 for the second application period on Cooks, due to this day being a Sunday – and it being culturally inappropriate to request a boat driver on the sabbath.

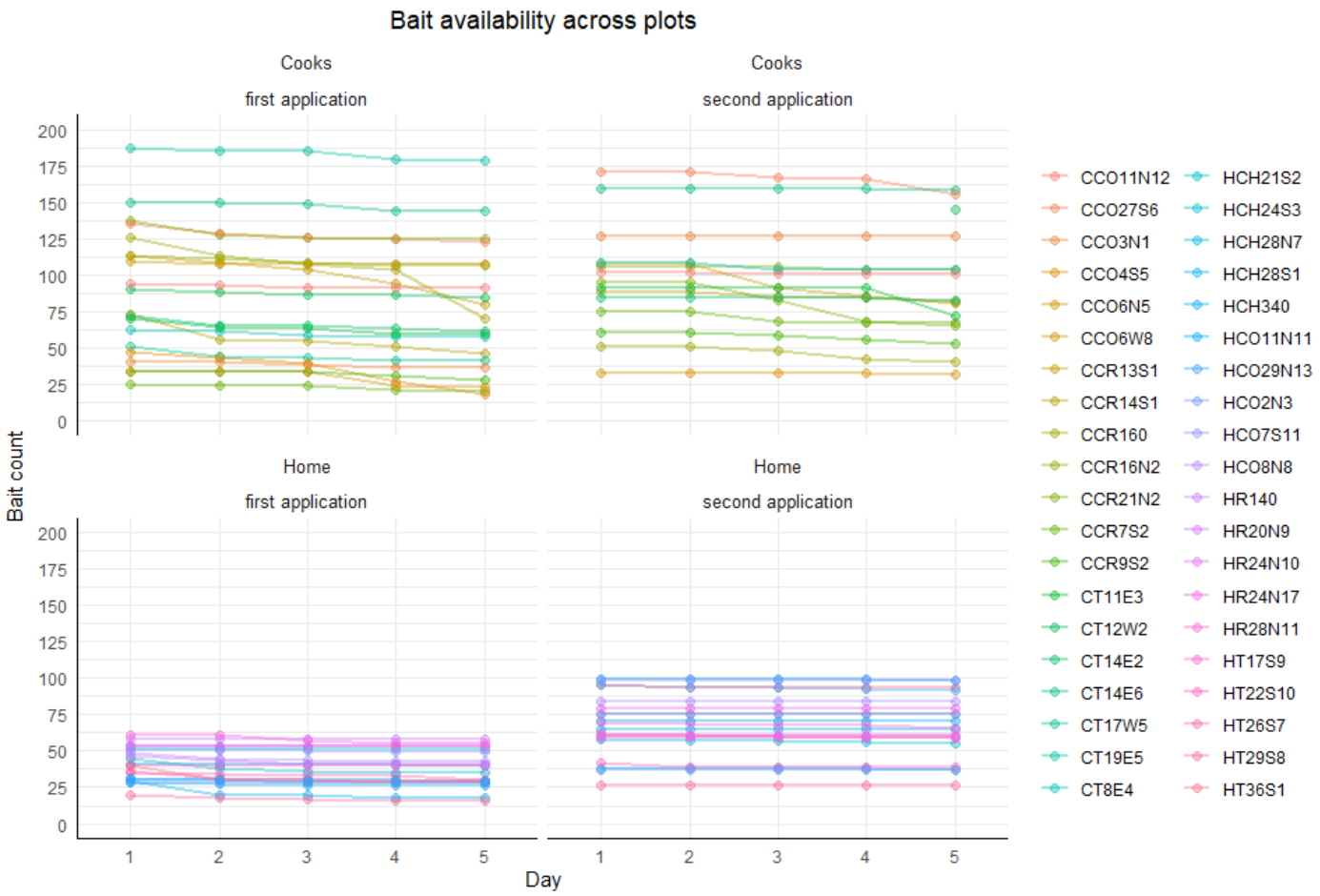


Figure 2.5.4: *Bait availability across all plots during the first and second broadcast applications.*

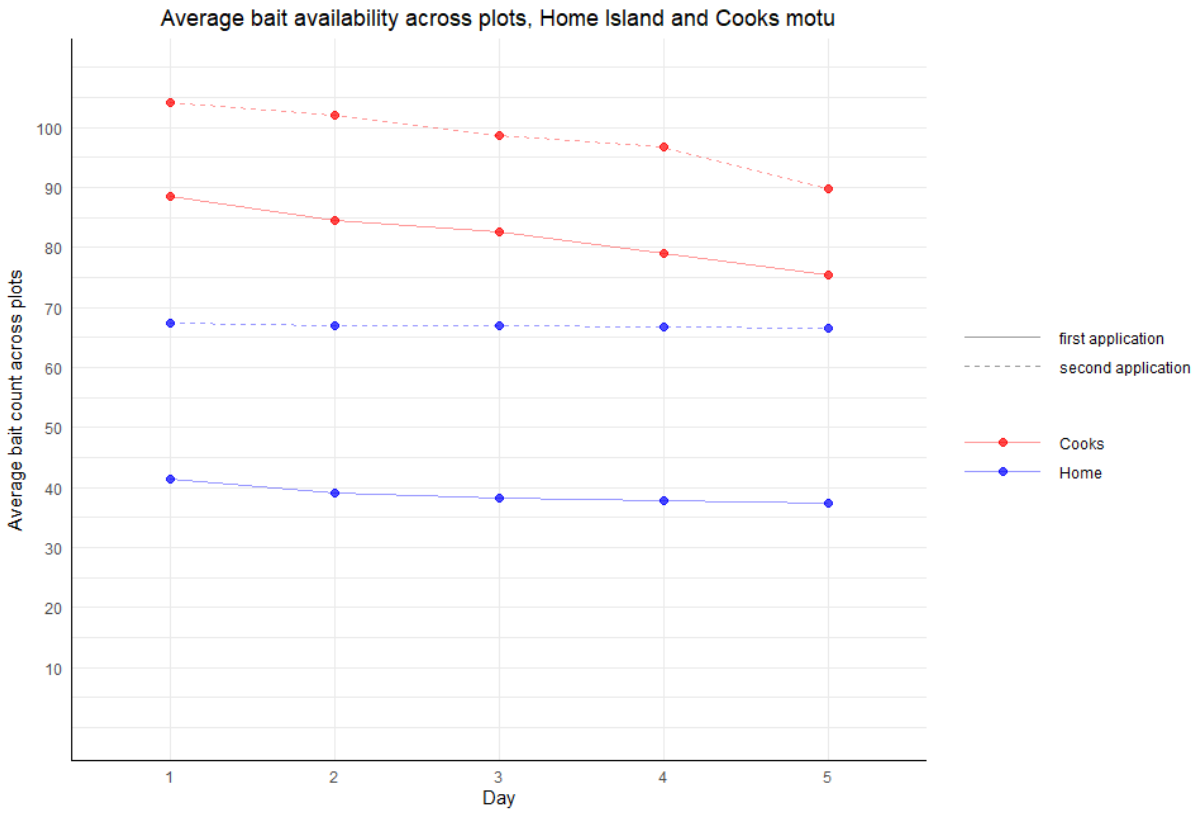


Figure 2.5.5: Average bait availability across plots during the first 5 days of the first and second broadcast bait applications

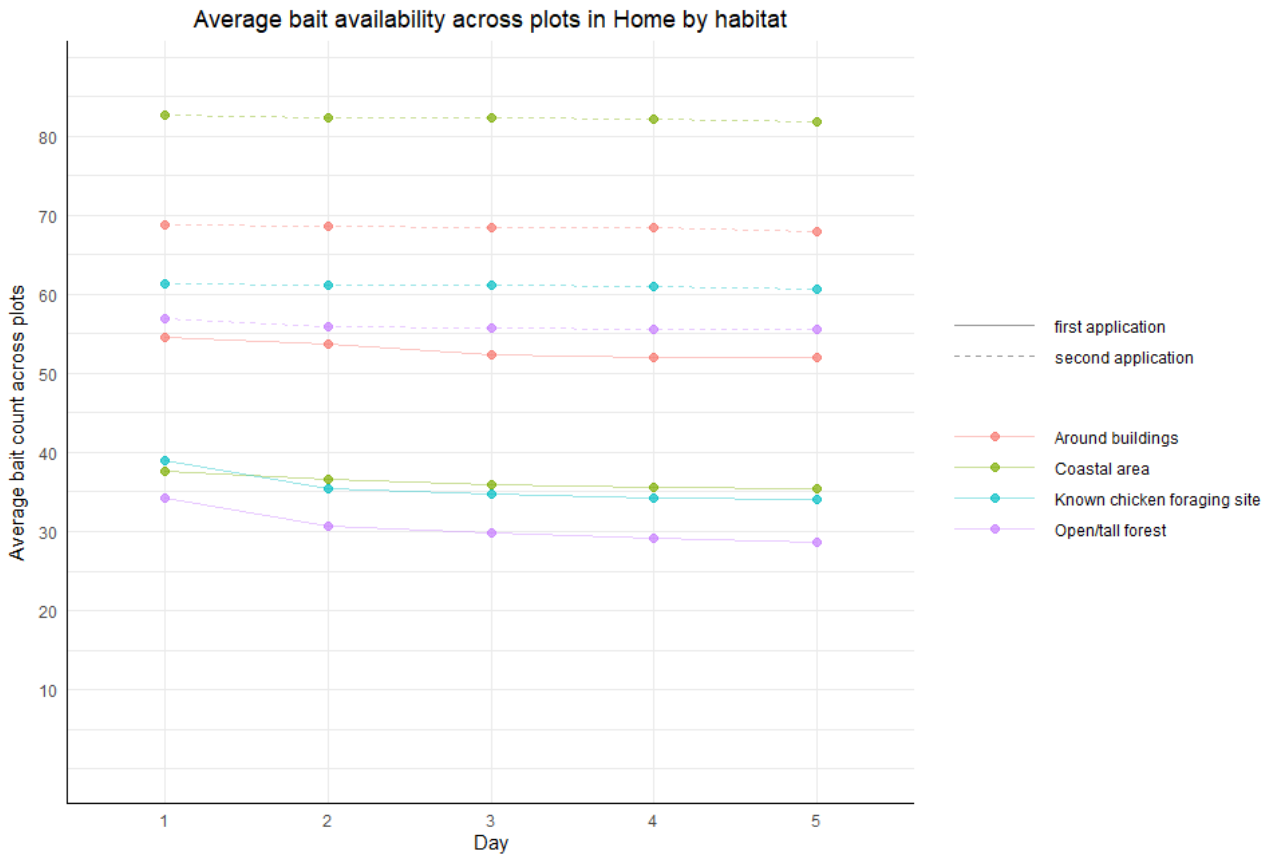


Figure 2.5.6: Average bait availability across plots on Home stratified by habitat during the first 5 days of the first and second broadcast bait applications

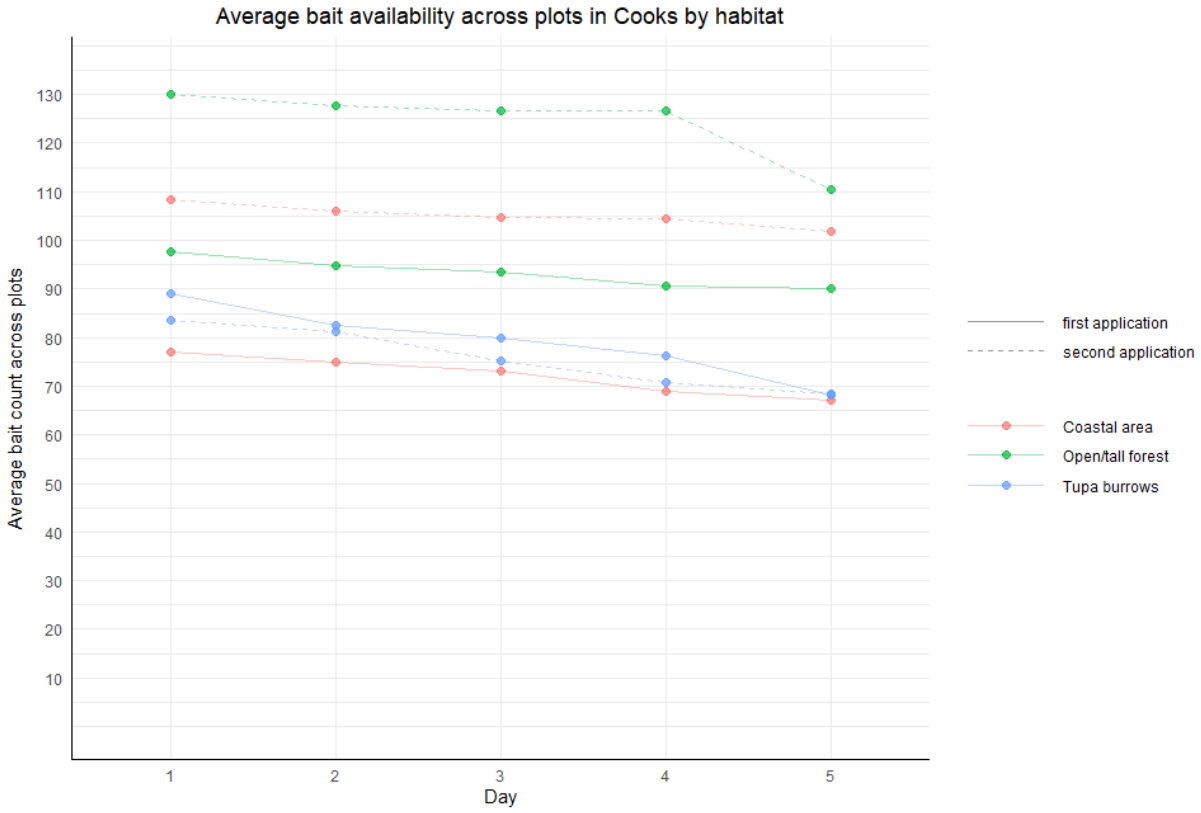


Figure 2.5.7: *Average bait availability across plots on Cooks stratified by habitat during the first 5 days of the first and second broadcast bait applications*

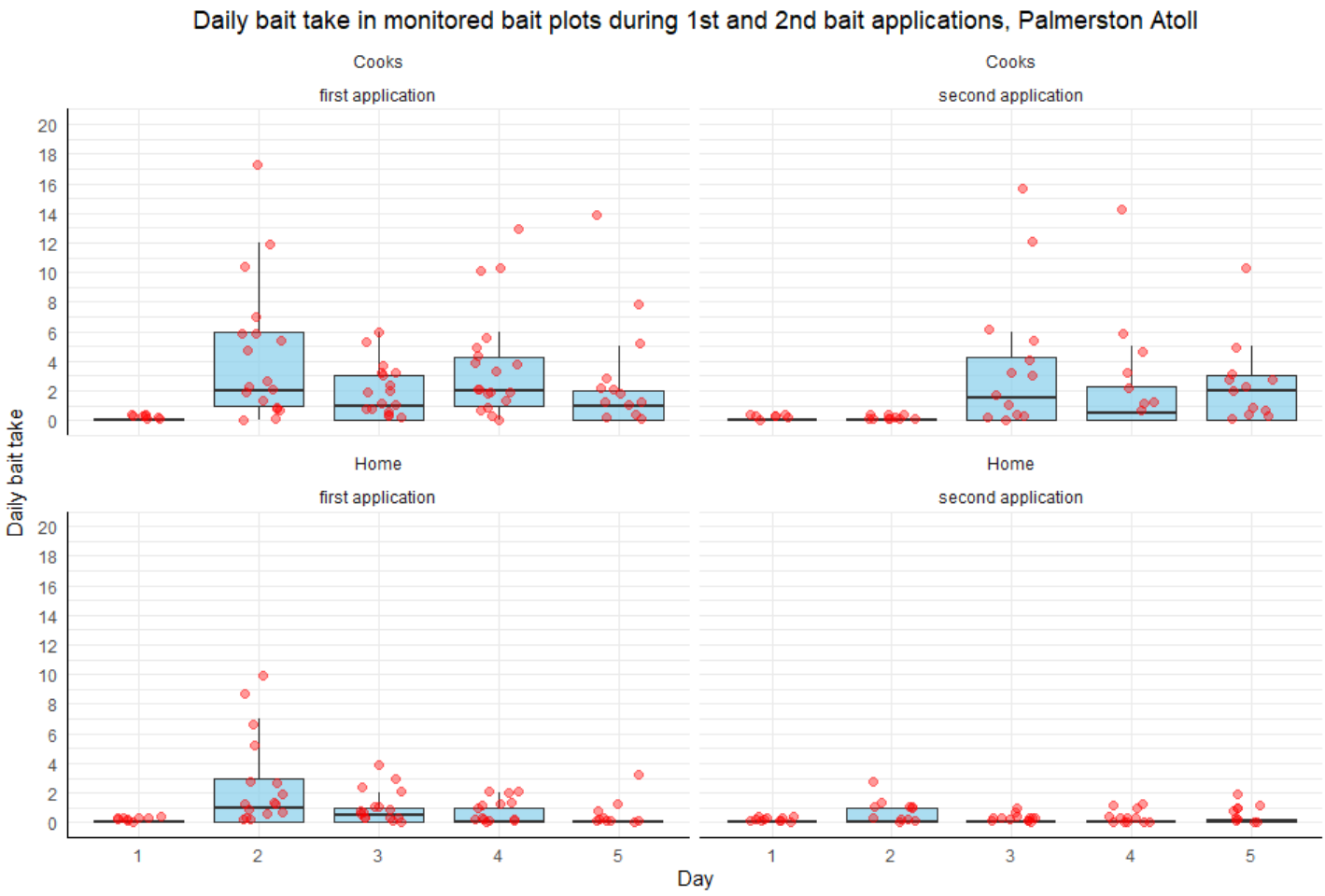


Figure 2.5.8: *Bait disappearance rate from plots during the first 5 days of the first and second broadcast bait applications. Day 1 is low due to it being the initial bait count; average bait take on Cooks is likely higher due to the effect of king tides on coastal plots and some land crab plots on the first application, and the effect of land crabs on bait take during both applications*

2.5.3 Informal bait availability observations

Bait spread and availability was also qualitatively monitored as the field team moved around the operation blocks during the day. Anecdotally, bait spread across the operational blocks was good; the tight grid and high application rates provided confidence bait was readily available. It was observed that bait was less noticeable in the puraka pits on Home island several days after the initial bait application, so an additional spot application was applied to these areas three days after the first bait application (see **Figure 2.4.1**). Heavily crab-burrowed areas in the 20-40 metres immediately around the interior marsh of Calcutta islet on Cooks motu had noticeably higher bait consumption than other areas, however bait was still consistently observable within grid squares in that habitat within 5 days of a bait application.

2.5.4 Building bait tray take

Bait trays in buildings (n=546-556) were serviced as per **Table 2.4.2** to ensure bait was available within buildings and infrastructure where rat home-ranges could exist that were not exposed to bait from the broadcast application on the baiting grid. As part of the bait tray servicing, bait-take data was collected for every individual tray. Bait trays with ongoing high bait-take were further investigated to determine the species responsible – either through site investigation, or through trail cameras being set up at the site on a timelapse mode (as opposed to motion detection) to ensure the target would be captured, since slow-moving cold-blooded hermit crabs, lizards and insects often did not trigger the motion detection sensors but turned out to be common non-target bait consumers within buildings.

Bait-take in bait trays significantly decreased after the first check, with most bait consumption taking place before the first check (day 1 to 3 after the first bait application). Around 130 trays were completely empty within 2 days, but this significantly reduced by the second check (2 days later) to 35 trays (see **Figures 2.5.9** and **2.5.10**.)

Bait trays that were empty on the second check tended to be trays that were lying in sheltered outdoor areas, where groups of hermit crabs that seemed habituated to food sources around residential areas were often observed consuming baits from trays rapidly (e.g. within an hour) of bait being placed. Trail cameras set on a timelapse function were used to validate cause of bait take on bait trays that that repeatedly had high bait-take after day 8. Camera footage revealed hermit crabs and large cockroaches as the usual culprits for bait-take. Geckos disturbing bait trays causing the spill of bait (e.g. spilling it onto the floor from trays up in rafters) were also responsible for bait disappearance in later bait tray monitors.

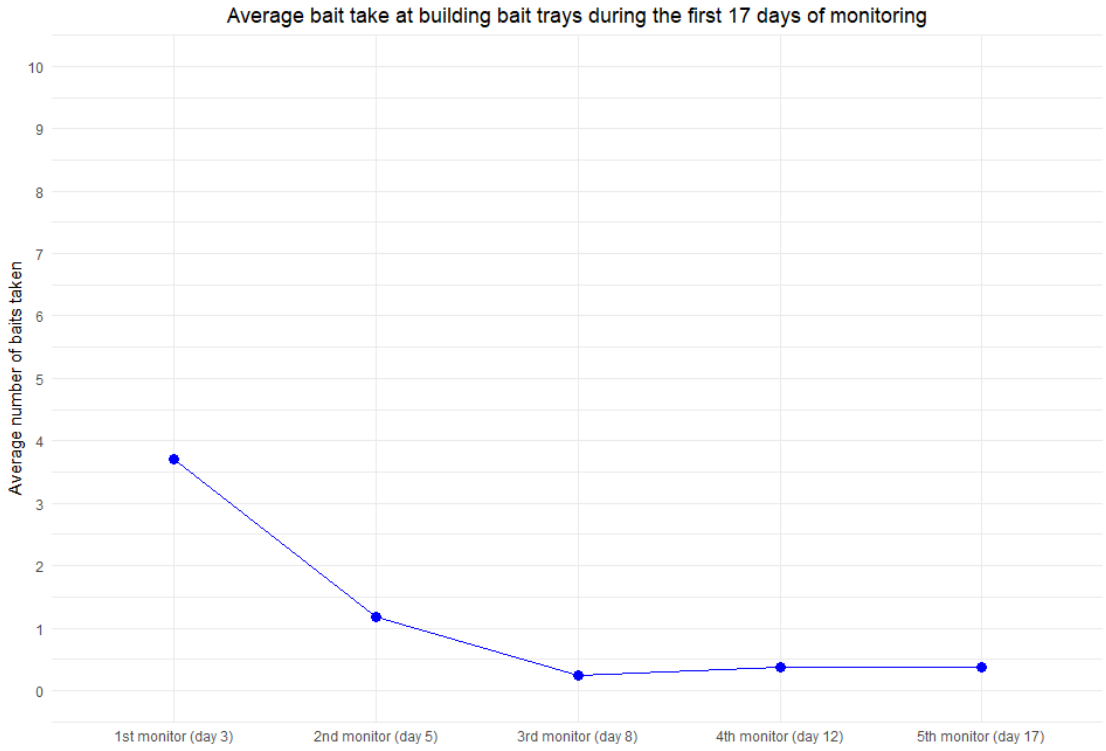


Figure 2.5.9: *Average bait take at building trays during monitoring period*

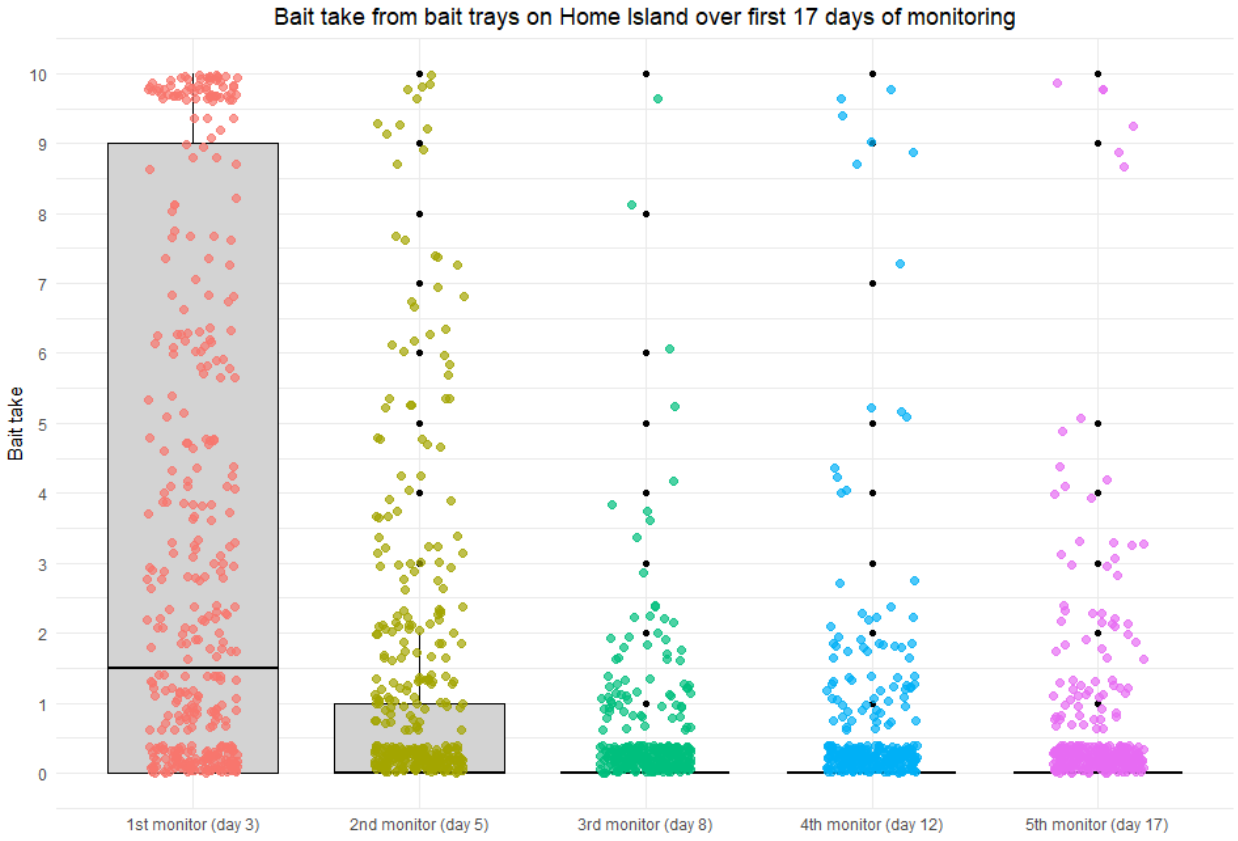


Figure 2.5.10: *Box and whisker chart showing average, quartiles, maximum and minimums of bait take and at building trays during monitoring period*

Figure 2.5.11: *Spatial and temporal display of bait take over the first 17 days of bait tray monitoring on Home Island.*

2.5.5 Observations of condition of bait

Observations of bait condition were that the bait condition from the first application was excellent until day 12, when rainfall occurred and moulding began (see **Figure 2.5.11**); however this bait degradation was offset by the second and third applications which led to bait in good condition being present throughout the operation areas in excess of 21 days.

Figure 2.5.11: *Left: first application bait and second application bait on Home Island on day 2 after second application; middle: first application bait vs second application bait on Cooks motu on 9/9/23; right: first application bait on Home Island 16 days after its application*

2.6.1 Bait and carcass monitoring

Bait and carcass monitoring was established at three locations on Home Island (see **Figure 2.5.1**) that represented broad habitat classes that were likely to be relatively different from one another in factors that govern bait and carcass degradation. Habitat classes were: agricultural (in a puraka pit); open sand; and tall forest with topsoil. Sites were established by placing five baits and three rodent carcasses at a site, with a fully enclosed crab/chicken/rat proof cage over them, then with a circular fence of chicken wire surrounding the internal cage.

Figure 2.6.1: *A bait and carcass monitoring site. Left: original bait and carcasses on initial setup day (without internal enclosure cage); right: the same bait and carcasses on day 27 post-setup (with internal enclosure cage)*

Sites will be monitored once a month, with the Palmerston biosecurity officer sending images of each site to the project manager. When baits and carcasses have completely broken down (expected time 3 – 6 months), the caution period for withholding livestock on the Island can cease.

2.7 Bait disposal and contingency bait

It was anticipated an approximate total of 4.1 tonnes of the 6 tonnes of PestOff 20R® procured would be used for two applications, with an approximate 30% contingency to allow for: bait spoilage; the ability to increase bait rates; and/or the late discovery of rat presence on other islets within the Atoll.

Based on bait availability monitoring, climatic variables, and the desire to have palatable bait present for a minimum of 21 days, the operation ended up delivering three broadcast applications, with some additional spot baiting totalling 4.6 tonnes of bait used. A further 300 kg of bait still in excellent condition was left in appropriate storage with the Island Administration to provide the community with the capacity to replace bait in bait trays, or spot apply bait if rats were seen once the field team had left.

Approximately one tonne of bait remained, all of which had advanced mould on it. This bait was disposed of following consultation with the manufacturer as to the most appropriate disposal method, and with the community as to a suitable on-island location. A pit was dug and hot fire base prepared to incinerate the bait. The remaining ash was then covered by approximately 20cm of sand and soil. The area of the incineration was done well away from human residences or agricultural plots.

Figure 2.7.1: *Disposal of excess mouldy bait on Palmerston: incineration (left), ashes (middle), burial (right)*

2.8 Improvements to biosecurity

Biosecurity infrastructure to detect and control new rodent arrivals was established across Home Island, and biosecurity processes were discussed and resolved between the project team, island administration, and community.

2.8.1 Rodent biosecurity infrastructure

10 DOC200 trap boxes with Victor® Wide Pedal mouse traps added were constructed and installed at permanent locations (see Appendix 5.1) at the highest risk area for rodent arrival around the northern beach (where all cargo and visitors to the island are landed). Traps will be baited with roasted coconut and peanut butter and set before any cargo is landed on Home Island, left set for two nights after cargo has landed from a vessel, and checked daily before being unset.

25 chewcard sites (see Appendix 5.1) were also permanently marked and labelled; these sites will have chewcards loaded with fresh peanut butter and icing sugar installed the day cargo has landed from visiting vessels, which will also be checked for two nights before being collected.

Wooden tunnels with double-set mouse traps were constructed, to be set and placed in any small boat that goes to receive cargo. These traps are to be left overnight in the small boats before being collected the following day.

40 wooden tunnels were constructed and stored, that can be used in a variety of ways for incursion response as per Appendix 5.2. Other biosecurity tools (including spare Victor® mouse and rat traps, rodent bait stations, wax tags, and trapping guidebooks) were packed in a set of labelled pails as a readily-accessible on-island incursion response kit.

2.8.2 Biosecurity processes for incoming cargo

Discussions took place with the Island Administration, and then the wider community, about improving the biosecurity processes around incoming cargo and visitors to Home Island, to prevent rodents re-establishing if the eradication proves successful. The following principles were agreed upon:

- The Biosecurity officer will go with small boats to all vessels unloading cargo
- High risk items - anything not sealed or that has cavities that rodents could get into – need to be visually inspected by the Biosecurity Officer, either on the deck of the cargo vessel or in the small boat, before it is landed on Home Island.
- Small boats must not land any cargo on the beach without the Biosecurity Officer having first identified that it is not a high-risk item
- All cargo is landed on north beach in the presence of people (already occurring)
- Where possible, cargo sent from Rarotonga should be placed in decommissioned freezers that effectively act as sealed containers, to reduce the risks of stowaways. This is already happening to a degree but encourage and build the capacity for it to be the default method of transporting goods with infrequent exceptions for oversize items.

2.9 General notes around project management

2.9.1 Team culture and management

A seven day work plan schedule was updated and maintained on a whiteboard at the team's base. The schedule was split by people, tasks, and day to allow each team member to be aware of the work schedule. Daily briefings occurred at approximately 0700 – 0730 hrs each morning, where the day's tasks, logistics, and health and safety were identified and discussed. Smaller briefings and feedback points occurred at lunch and dinner time. Although feedback and improvements from daily briefs were integrated into operational activities, formal debriefs for significant activities (grid layout, grid baiting, accident response) occurred as a team shortly after their completion.

Team leader roles (for grid layout, grid baiting, building baiting, monitoring, and biosecurity) were allocated to DOC staff members who had experience in these areas from other expeditions. Other key roles that were allocated included gear manager, work schedule recorder, data champion (management and quality control), daily events record keeper, gear/technology technician, and safety overseer. The project manager oversaw the team leaders, formally led liaison with the community and Island administration and managed the performance and health/wellbeing of all field team members.

The field team contained a mixture of staff with experience in eradication operations – to staff that had little to no experience in pest control. Some of the approaches used to ensure quality control and training less experienced team members (including the community) included

- Written maps/instructions
- Talking through new tasks as a team
- Initially carrying out a task with a physical demonstration and run through as a team to ensure understanding of protocol and quality control
- Managing team members into smaller groups with more experienced members being allocated to less experienced members, to enable demonstration, followed by supervision, then enabling independence with methodology and protocol to ensure quality control and capacity building.
- Allowing for people's person style of implementing tasks, but ensuring bottom lines with quality control and outlining specifics where deviation was not acceptable for methodological/quality control reasons
- Encouraging all of team to do quality control, i.e. Cook Island members could point out anything that could be done better by DOC members just as much as vice versa
- Acknowledging that all team members had more or less experience in different things, e.g. DOC staff had more experience in rat control but far less experience in working in a Pacific Atoll social and ecological environment; and some of the Rarotongan staff had experience with a previous eradications in the Cook Islands to draw on.

2.9.2 Field gear and resources

Field gear was stored in boxes with items for specific tasks grouped together; team members were expected to return items and make repairs as needed (e.g. sharpening machetes) at the end of each day. This enabled shared equipment to remain locatable and in good condition. An allocated gear manager ensured that all electronic devices were collected and put on charge by the end of the day to prevent losing equipment to power failure in the field.

A gear technician ensured that each morning all field team members had the latest iteration of the project's geodatabase on their Mergin Maps mobile app; and that RTK gear was correctly calibrated and functioning.

A data champion ensured that all data was synchronised from the Mergin Maps project at the end of the day, and that all data entries had been completed on the main geospatial database.

A mobile Starlink setup was established at the field base to enable the use of cloud synchronisation to enable mobile data collection and reporting for the project.

2.9.3 Working with the community

The community were considered as the wider field team, with acknowledgement that without every individual's participation in the project, the project would have a significantly increased risk of failure. Monthly communications between the project manager and the Island administration prior to the team's arrival ensured that the community were on track with their management actions; and the use of social media (a private facebook page) managed by the project manager allowed to keep contact with the wider community about the project's progress.

The community was small enough (28 people) that during the field period, it was relatively easy to ensure all individuals were well briefed and updated on day-to-day tasks. All-of-island formal community meetings were also held three times over the field period to brief the community, identify any potential issues, and provide a feedback loop. Day to day informal interactions with each household were also important to build upon the relationships that had already been formed by many of the field team members from the November 2022 feasibility study visit.

It cannot be over-emphasised how much of the project relied on the building and development of good relationships between members of the field team and the community, as well as between members of the field team. The initial field visit to Palmerston during the November 2022 feasibility field work was essential for initiating relationships with the community and partner organisation staff, which was then developed and built on through communication via video conferencing, emails, phone calls, and social media during the eight month gap that bridged the feasibility and operation delivery period. Informal relationships with all families and individuals between the project manager and members of the field team were essential to build the trust required by the Palmerston community to enable the actions required to implement the eradication. Observing and participating in cultural and religious practices, a mixture of formal and informality, being able to be friendly and relatable to the community, and a mixture of compatible personalities within the field team to be able to engage with all members of the community were essential elements in achieving this.

As mentioned in section 2.1.6 – engagement and compliance by the community relied on relationships and social capital between the project manager and field team with the community. The project relied on the engagement, participation, and social structures of the Palmerston community to carry out the required implementation of the operational plan. Future eradication planning for inhabited islands ignore the value of social capital and relationships to their peril.

2.9.4 Value of planning and redundancy

DOCs best practice for Operational Planning for Animal Pest Operations (DOC, 2023), and the Pacific Invasives resource kit for rodent eradications (https://www.pacificinvasivesinitiative.org), were used as guides for project management. The detailed planning and redundancy required to be specified under these frameworks consistently proved to be of value – there were many times during the project where redundancy was called on with regards to shipping logistics, human resources, field gear, and bait.

The best practice frameworks, as well as the process of peer review with the DOC Island Eradication Advisory Group, provided a robust project planning framework to allow for adaptive management when variables changed – mitigating risks to the project.

3. Recommendations and follow-up actions

3.1 Eradication validation monitoring

Monitoring to inform whether the eradication has been successful or not should take place no earlier than February 2024. As resources and technical knowledge around rodent monitoring is limited on Palmerston, this monitoring will need to be designed and supported by DOC. Key resources have been left with the biosecurity officer to undertake this task, but more resources and support will be needed to have confidence in validating a successful eradication. On-site support from an experienced practitioner should be seriously considered to provide the confidence of absence of rats on both islands within a one-year period.

3.2 Community ownership and leader-led buy-in of biosecurity on the Island.

It is likely families currently absent from the Atoll will return in the coming years, and it is important that the community ensure that the biosecurity processes, actions, and principles agreed upon are upheld. Island administration and the Island council need to ensure cargo coming to the Atoll is to a satisfactory biosecurity standard, and that the agreed biosecurity processes for inspecting cargo before landing on the Island are followed by and supported by the community and cargo ships.

3.3 Build capacity and redundancy for biosecurity management on Palmerston

The current Island biosecurity officer has several other roles and duties for Island administration. The upskilling in biosecurity processes and systems concentrated on this one individual, however, there is little to no redundancy if the current biosecurity officer left the Atoll. It is recommended that another suitable candidate is trained by the current biosecurity officer in the systems in place – and biosecurity/cargo checks are done jointly or alternately to ensure both individuals remain current with these skill sets.

3.4 Build on the capacity foundations laid for Cook Island staff in pest control and biosecurity

Three staff/associated staff from Te Ipukarea Society have now had experience in two different small Atoll rat eradication projects (Suwarrow and Palmerston) as field team members. Future rodent eradication projects in the Cook Islands should look at providing opportunities and mentoring for best practice operational planning for such individuals to elevate their experience from field members to being involved with project and operational planning to truly build animal pest management capacity in the region.

3.5 Integrate RTK equipment into best practice

The use of Real Time Kinematic equipment for the establishment of grids in future invasive animal eradications requiring high spatial resolution should be considered. Grid establishments using RTK equipment should be added as an option for best practice ground based rodent eradications.

4. References

Department of Conservation. 2023. Operational Planning for Animal Pest Operations. Standard Operating Procedure. DOCDM-1488532

Oyston, E. 2023. Feasibility assessment of the eradication of ship rats (R.rattus) and kiore (R.exulans) from Palmerston Atoll, Cook Islands. Department of Conservation internal report. DOC-7260876.

Oyston, E. 2023. R.rattus and R.exulans eradication Operational Plan, Palmerston Atoll, 2023. Department of Conservation internal report. DOC-7472159.

Appendix 1: Trial use of RTK equipment for grid establishment

The project trialled the use of Real Time Kinematic (RTK) equipment for the creation of the grid instead of handheld GPS units or string line and sighting compass methods. RTK technology was identified as having the potential (and this potential was realised in the field on Palmerston) to provide very accurate geolocation (~10cm accuracy), with each grid point having an independent level of accuracy, and to significantly speed up the grid creation process due to the planning that could be done beforehand and the elimination of the requirement to follow a straight compass bearing between points in thick vegetation or otherwise hazardous terrain.

Using the RTK gear also enabled mobile data collection and geospatial management and planning to be integrated into the project – simplifying advance planning, site labelling, task delegation, and data collection for the grid layout.

Figure 2.7: *Mergin maps mobile data collection and navigation project being used with an RTK rover pole to establish the baiting grid (left); an Emlid RTK unit set up as the base RTK unit on Home Island (right)*

The equipment used consisted of 4 x Emlid Reach RS2 units, with one set up as a base unit positioned on a known base coordinate aligned with high resolution drone imagery taken the previous November during the feasibility study. The remaining 3 units were used as 'Rovers', being carried and commanded by team members who navigated to points on a pre-generated grid using a preprogrammed project on a mobile Geographic Information Systems (GIS) application (Mergin maps).

During the operational planning phase, a 19 by 19 metre grid was generated across the aerial imagery of the operation blocks using the software package QGIS, then oriented and fine-tuned appropriately (for example grid points were removed from open spaces and buildings). The grid points were then named using a set convention. Associated metadata was then linked to these points to allow in-field data collection that was stored in a geodatabase which acted as a repository for all geospatial-related monitoring data for the project (such as baiting, bait availability, building baiting, issues, and bait and carcass degradation monitoring).

This geodatabase was uploaded to a mobile GIS platform (Mergin maps) on field team members' phones, which linked through a Bluetooth connection to the RTK devices to act as the navigational antennae for the mobile phones. The Mergin maps tools then assisted navigation to the pre-planned grid points, usually to within ~<10cm accuracy, and associated metadata could be entered or retrieved (e.g. date and time established, who established, line and transect

ID). Other members in the team followed the navigator with the RTK gear cutting vegetation *en route*, and physically marking and labelling the grid points.

Progress and data on the mobile application could be synced via the cloud (using a Starlink system at the fieldbase), allowing updates on progress to be shared across the team throughout the day and for data to be easily shared and managed. This increased the agility of planning and management of the grid, and provided the ability to have good quality control in terms of any grid points that may have been missed.

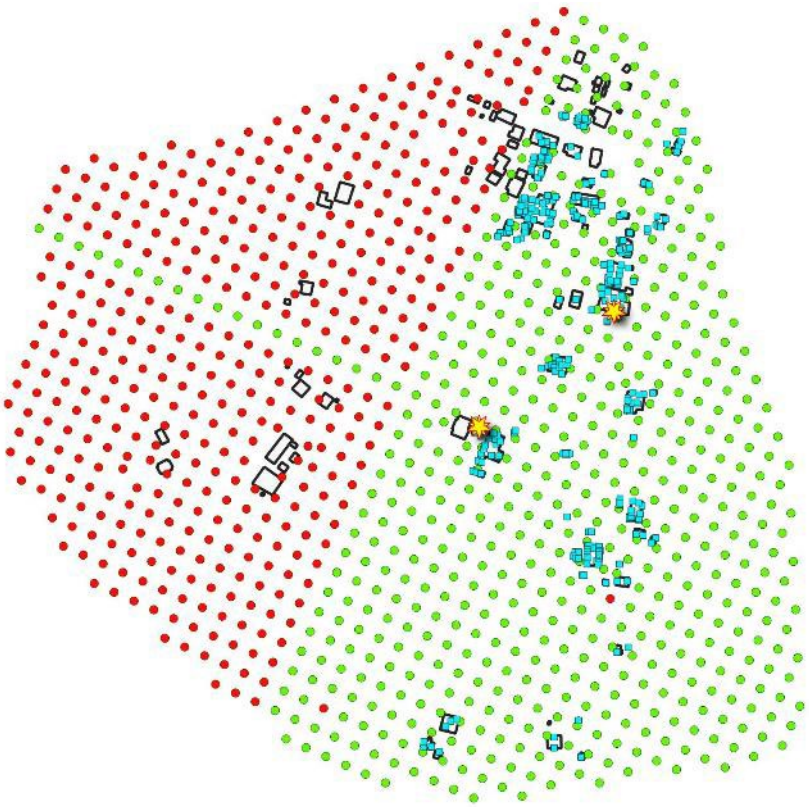


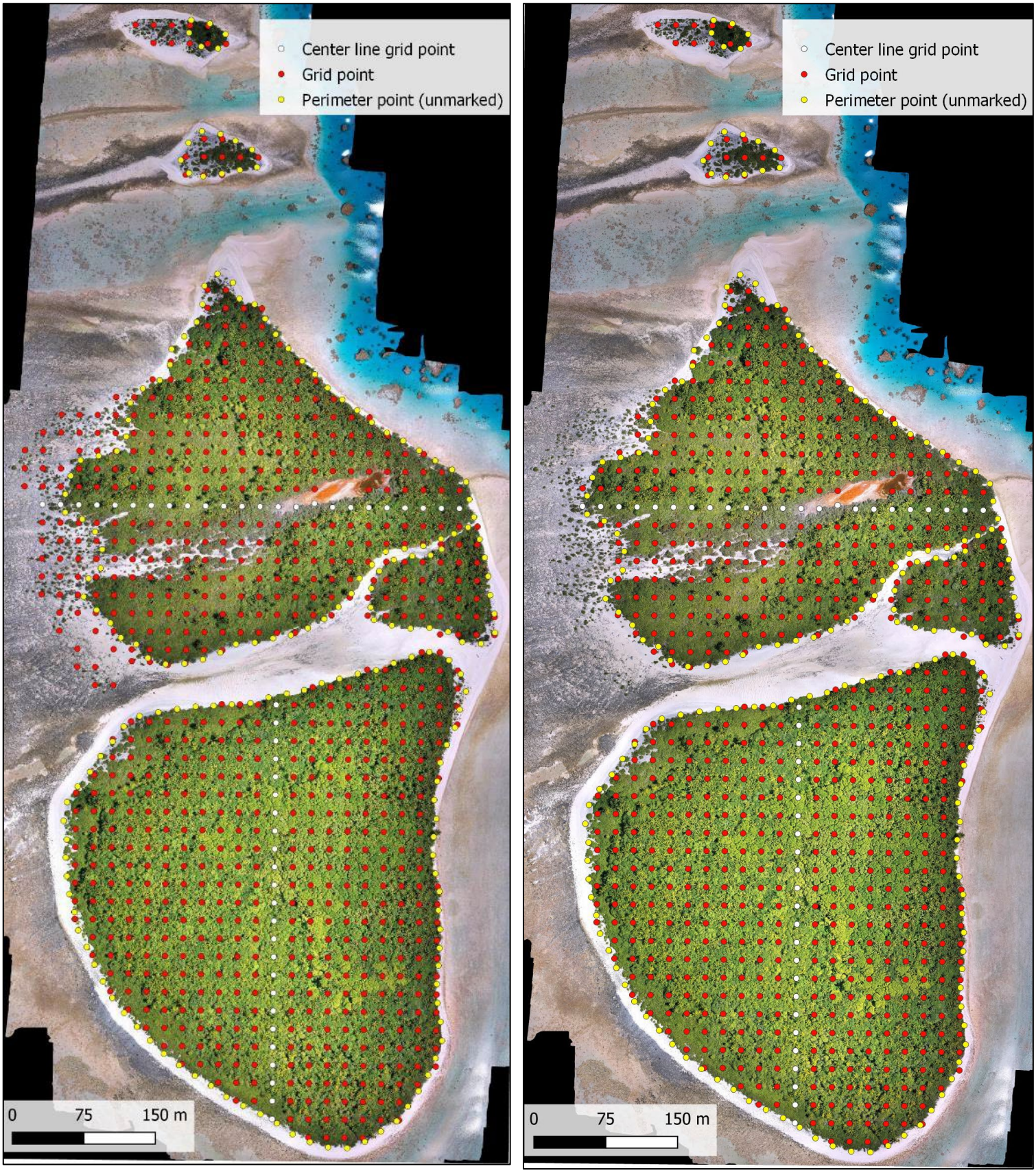
Figure 2.8: *An example of the Mergin maps project accessible on field team members' phones, showing progress on the Home Island grid creation on the 12th of August. Green dots show established grid points, red dots show grid points not established, yellow stars demarcate a site with an issue (has associated metadata, e.g. "a starfruit tree with ripe fruit"), and blue squares show established building bait trays. Note the benefit this has for quality control, with the two missed red grid points in the mostly completed grid areas being easily identified.*

The result of the trial use of the RTK gear was a very accurate grid, with much improved abilities for team leaders and the project manager to monitor progress and quality control, and for improving the quality and systems of data management. The accuracy of the resulting grid was much better than what would have been achievable with GPS handheld units (at best +/- 3m accuracy when not under canopy), or string line and compass (where accuracy is relative to the previous point measured from – so inevitable inaccuracies typically compound).

The RTK and mobile application equipment also allowed the grids to be laid out significantly faster than using traditional methods, and for teams to work independently from each other rather than in parallel as with traditional methods. Creating the grids over the 65 hectares of both Home and Cooks took 80 person days. It is estimated that it would have taken at least 240 person days using the string line and sighting compass methods to produce a less accurate grid, risking more health and safety incidents and lower morale in the field team due to fatigue.

Appendix 2.1: Home Island broadcast grid

Appendix 2.2: Cooks motu baiting grid: first application (left), second and third application (right)



Appendix 3: Bait application diary

Bait caching: 22/8/23: Bait buckets cached around Home Island on baiting lines in preparation for first broadcast application. Bait buckets taken to Cooks for storage but not cached on grid yet.

Bait caching: 23/8/23: Bait buckets cached around Cooks motu on baiting lines in preparation for first broadcast application

Building baiting: 26/8/23 (initial bait deployment – day 1): 556 bait trays were filled with 10 x 2 g PestOff 20R® baits, across 116 buildings. Records were entered into a mobile data collection application as bait was delivered to ensure quality control and bait was successfully delivered to the planned locations. Building baiting was done by 3 people, with 2 additional people doing quality control checks throughout the day. There was a quality control issue found with one of the baiters, and as a result the majority of their trays were revisited to ensure the intended bait trays were filled. This quality control issue was largely due to the lead building baiter being unavailable and the system designed to be used was not being used by the replacement building. This issue was ironed out after the initial deployment. Building baiting took approximately 24 person hours.

There were 23 locations in buildings where bait was broadcast, due to amounts of three-dimensional habitat that deemed broadcasting appropriate, and potential health and safety risks of trying to navigate through cluttered old materials.

Broadcast: 28/8/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Home Island. The Island was divided into 5 sub-blocks, allocated to 7 different baiters. At each baiting point a total of 800g of PestOff 20R® was broadcast in 6 directions (4 long-range throws at 0, 90, 180, and 270 degrees, and 2 short-range throws at 180 degrees each side of the baiter) using pre-measured scoops. An additional broadcast application was done at 20 metre GPS-guided spacings around the island's perimeter.

A total of 757.3kg of bait was used for broadcast baiting (not including the perimeter) which equates to an average nominal on-the-ground rate of 21 kg/ha. An additional 77.3kg of bait was used over the coastal perimeter, at least doubling the average nominal application rate for the vegetated coastal 10m swath.

541 building bait trays were checked on the broadcast application day, with bait take recorded for each tray, and trays replenished to 10 baits per tray.

20 pre-established 25 m^2 bait availability plots had baits marked for an initial count

This day took approximately 132 person hours, not including time spent caching bait buckets.

Building baiting: 28/8/23 (first monitor – day 3): 552 building trays were checked for bait take. Bait take was recorded at each tray, and if fewer than 10 baits were present trays were replenished back to 10 baits.

Broadcast: 29/8/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Cooks motu. The Island was divided into 5 sub-blocks, allocated to 7 different baiters. A total of 1200 g of PestOff 20R® was broadcast in 5 directions (4 long-range throws at 0, 90, 180, 270 degrees, and 1 short-range 360 degree throw) from each baiting point. An additional broadcast application was done at 20 metre GPS-guided spacings around the island's perimeter.

A total of 947.1 kg of bait was used for broadcast baiting (not including the perimeter) which equates to an average nominal on-the-ground rate of 33.6 kg/ha. An additional 199.1 kg of bait was used over the coastal perimeter, at least doubling the average nominal application rate for the vegetated coastal 10m swath.

20 pre-established 25 m^2 bait availability plots had baits marked for an initial count.

This day took approximately 100 person hours, not including bait caching and bucket retrieval.

Broadcast: 30/8/23: 67 rubbish pits were baited with additional bait (using an additional total 21 kg of PestOff 20R®). Puraka (a form of taro) patches were also baited with an additional 30 kg of bait in total over the four patches on the island.

Building baiting: 30/8/23 (second monitor – day 5): 551 building bait trays were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray.

Building baiting: 1/9/23 (extra check of high consumption trays – day 7): An additional check was done on trays which had more than 5 baits consumed on the previous check (n = 36)

Bait caching: 02/9/23: Bait buckets cached on Cooks motu along baiting transects for the second broadcast application.

Building baiting: 2/9/23 (third monitor – day 8): 552 building bait trays were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray.

Building baiting: 6/9/23 (4^{th} monitor- day 12): 538 building bait trays were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray. An additional 2 trays were checked on the 9/9/23 as they were missed on the 6/09/23. 12 trays were not checked as the house owner (Will Rowe) would not respond to communication.

Bait caching: 06/9/23: Bait buckets cached on Home Island along baiting transects for the second broadcast application.

Broadcast: 07/9/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Home Island. The Island was divided into 5 sub-blocks, allocated to 7 different baiters, and another person allocated to do the additional perimeter baiting. At each baiting point a total of 650g of PestOff 20R® was broadcast in 5 directions (4 long-range throws at 0, 90, 180, and 270 degrees, and 1 short-range 360 degree throw around the baiter) using pre-measured scoops. An additional broadcast application was done at 20 metre GPS-guided spacings around the island's perimeter.

A total of 640.15kg of bait was used for broadcast baiting (not including the perimeter) which equates to an average nominal on-the-ground rate of 16 kg/ha. An additional 60.3 kg of bait was used over the coastal perimeter, at least doubling the average nominal application rate for the vegetated coastal ~10m swath.

20 pre-established 25 m^2 bait availability plots had baits marked for an initial count.

This day took approximately 80 person hours with 10 people, notably less than the first application day as building baiting was done the day before this time. This does not include time spent caching bait buckets.

Broadcast: 09/09/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Cooks motu. For the second application, the operation block was reduced to 27 hectares (originally 28.8 ha) due to king tides during the baiting period taking bait from the first application into the marine zone. The island was divided into 5 sub-blocks, allocated to 7 different baiters, with an additional person baiting the perimeter . A total of 1200 g of PestOff 20R®

was broadcast in 5 directions (4 long-range throws at 0, 90, 180, and 270 degrees, and 1 short-range 360 degree throw) from each baiting point. An additional broadcast application was done at 20 metre GPS-guided spacings around the island's perimeter.

A total of 1090 kg of bait was used for broadcast baiting (not including the perimeter) which equates to an average nominal on-the-ground rate of 33.8 kg/ha. An additional 176.64 kg of bait was used over the coastal perimeter, at least doubling the average nominal application rate for the vegetated coastal 10m swath.

17 pre-established 25 m^2 bait availability plots had baits marked for an initial count. It took notably longer to complete bait availability plots due to the team running out of flag markers (due to bait density of combined first and second applications) and having to make more on site. 3 plots of the planned 20 were dropped due to running out of daylight hours and marking materials.

This day took approximately 110 person hours, with approximately half of that being plot measurements, and not including bait caching and bucket retrieval.

Building baiting: 11/9/23 (5th monitor – day 17): 546 building bait trays were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray. Bait trays in the Rowe household were checked, refilled, and reported on by the home owner.

Bait caching: 11/9/23: Bait buckets cached on Cooks motu along baiting transects for the third broadcast application.

Bait caching: 12/9/23: Bait buckets cached on Home Island along baiting transects for the third broadcast application.

Broadcast: 13/09/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Cooks motu. For the third application, the operation block was reduced to 27 hectares (originally 28.8 ha) due to king tides during the baiting period taking bait from the first application into the marine zone. The island was divided into 5 sub-blocks, allocated to 7 different baiters. No additional perimeter baiting was done. A total of 480 g of PestOff 20R® was broadcast in 5 directions (4 long-range throws at 0, 90, 180, and 270 degrees, and 1 short-range 360 degree throw) from each baiting point. An additional broadcast application was done at 20 metre GPS-guided spacings around the island's perimeter.

A total of 366.2 kg of bait was used for broadcast baiting which equates to an average nominal on-the-ground rate of 13.5 kg/ha.

This day took approximately 72 person hours including bucket retrieval.

Broadcast: 14/09/23: Hand broadcast baiting was completed over a 18.9 x 19.0 metre grid across the entirety of Home Island. The Island was divided into 7 sub-blocks, allocated to 10 different baiters. No additional perimeter baiting was done. A total of 480 g of PestOff 20R® was broadcast in 2 directions (one scoop thrown forward 180 degrees, and one scoop thrown back 180 degrees) from each baiting point. No additional perimeter baiting was done in this application.

A total of 456.3k g of bait was used for this application baiting perimeter which equates to an average nominal on-the-ground rate of 12.7 kg/ha.

No bait availability plots were established for this application.

This day took approximately 40 person hours, not including bait caching.

Building baiting: 18/9/23 (6th monitor – day 24):

35 building bait trays that had one or more baits taken from them in the day 8 - day 17 period were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray. Trail cameras set on timelapse mode were placed at bait trays where more than individual baits were being taken over the pass two checks to confirm the culprit species.

Building baiting: 24-25/9/23 (7th monitor – day 30-31):

546 building bait trays were checked, with bait take recorded for each tray and trays replenished to 10 baits per tray.

Building baiting: Week of the 30/10/23 (Disestablishment – day 66)

Bait trays are intended to be collected and all bait appropriately disposed of by the community, led by Island administration staff.

Appendix 4: Biosecurity infrastructure

4.1 Biosecurity infrastructure maps:


CC12
CC13
CC22
CC23
CC21
CC24
CC15
CC16
CC17
CC25
CC20
CC19
CC18

4.2 Examples of wooden tunnels with different monitoring or response setups:

Appendix 4.2.1: Wooden tunnel with victor rat traps installed – two opposing rat traps with treadles facing tunnel entrances. Bait and set the traps then push inside

Appendix 4.2.2: Wooden tunnel with victor mouse traps installed – two mouse traps with treadles facing opposing walls. Bait and set the traps then push inside

Appendix 4.2.3: Wooden tunnel setup with wire to hold poison bait block

Appendix 4.2.4: Wooden tunnel with tracking card installed. Wire peg can be used to hold bait (toasted coconut flesh)

Appendix 4.2.5: DOC200 trap box with mouse trap. Traps set and ready, with toasted coconut flesh on side bait nail, and mouse trap baited with peanut butter.

Appendix 4.3: *Examples of chew card site and placement. Red tags mark permanent chew card monitoring sites or trap sites. Chew card has peanut butter smeared in the corflute holes on each side, and is labelled with chew card ID and date for future reference.*

Appendix 5: Links to project data

All project data is stored in the DOC National Eradication Team's Onedrive repository (contact the National Eradication Team within DOC for permissions to be granted)

\OneDrive- Department of Conservation\Shared Documents- National Eradication Team\Documents by projects\Palmerston atoll\

Operational planning leading up to the delivery period can be found in the folder structure:

\OneDrive- Department of Conservation\Shared Documents- National Eradication Team\Documents by projects\Palmerston atoll\Eradication operational planning\

All data recorded and documents made during the field period can be found in the folder structure:

\OneDrive- Department of Conservation\Shared Documents- National Eradication Team\Documents by projects\Palmerston atoll\Palmerston August September 2023\