Lord Howe Island Rodent Eradication Project

Final Report - Lessons Learned

Lord Howe ISLAND BOARD

NSW GOVERNMENT

Edition 1 – November 2025

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Cover Image: Aerial view of Lord Howe Island, Credit: Jack Shick

“Lord Howe Island is so extraordinary, it is almost unbelievable… Few islands, surely, can be so accessible, so remarkable…”

Sir David Attenborough (1998)

“Rodents are linked to the extinction of 75 species [globally] - 52 bird, 21 mammal, and 2 reptile species – or 30% of all contemporary extinctions.”

Doherty et al. (2016)

“Rats have already been implicated in the extinction of five endemic bird species, at least 13 species of endemic invertebrates, and two plant species on Lord Howe Island.”

Lord Howe Island Rodent Eradication Project (2018)

Table of Contents

Acknowledgements

First and foremost, we thank the Lord Howe Island community for their understanding, patience, and support during the 2019 Rodent Eradication Project, 2021 Rodent Response and 2023 Checkpoint, as well as for the rich history of environmental stewardship and the ongoing commitment to protecting their island home.

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Glossary

Term / Abbreviation	Definition in this Report
APVMA	The Australian Pesticides and Veterinary Medicine Authority
Community	Permanent, temporary and previous residents of Lord Howe Island
CPT	Community Planning Team
DEC / DECC / DECCW / DCCEEW	The Department of the New South Wales Government that oversees the Lord Howe Island Board – currently known as the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Previously known as Department of Environment and Conservation (DEC), Department of Environment and Climate Change (DECC).
Dollars ($)	Australian Dollars
EAS	The air transport company known as Eastern Air Services
EPBC Act	The Environmental Protection and Biodiversity Conservation Act (1999)
GIS	Geographical Information Systems
LHI	Lord Howe Island
LHI Board	The Board members of the Lord Howe Island Board.
LHIB	The organisation known as the Lord Howe Island Board, or the Lord Howe Island Board Administration Office.
MV Island Trader	Marine Vessel Island Trader – the vessel that services Lord Howe Island
NPWS	The New South Wales National Parks and Wildlife Service
NSW	New South Wales, Australia
NZ	New Zealand
PMP	Property Management Plan – a plan of access to people's properties during the Lord Howe Island Rodent Eradication Project
PPP	The Lord Howe Island Permanent Park Preserve
QANTAS	The air transport company known as the Queensland and Northern Territory Air Service
REP	The Lord Howe Island Rodent Eradication Project (2019)
Rodent	House Mice (*Mus muculus*) and Black Rats (*Rattus rattus*)
RRP	The Lord Howe Island Rodent Response Project (2021)
Settlement	The settled area of Lord Howe Island, including the southern and northern settlements.
WEP	The Lord Howe Island Weed Eradication Program

Executive Summary

The Lord Howe Island Rodent Eradication Project (REP) stands as a monumental achievement in conservation history – delivering immense benefits to the island's unique biodiversity. As the first large-scale eradication of rodents on an inhabited island, it played a crucial role in restoring native habitats and safeguarding threatened species, as outlined in the Lord Howe Island Biodiversity Management Plan. It has resulted in a significant and measurable resurgence in biodiversity within the Lord Howe Island World Heritage Property – with increased populations of endemic birds, invertebrates and flora. This project was the most complex rodent eradication ever attempted and set a benchmark globally for invasive species eradication as an ecological restoration method on inhabited islands.

An undertaking of this scale had no written guidebook available, which meant that throughout the project, many lessons were learnt as problems arose and the project team adapted as they went. Appendix 1: Summary of Lessons Learned provides a concise summary of these lessons, which are expanded on throughout this report. All the people involved in the project are commended for their passion and dedication to ensuring the Lord Howe Island Rodent Eradication Project was successful.

Effective and genuine community engagement will play a pivotal role in any similar project - fostering a sense of ownership and ensuring sustained support for conservation effort. Alongside community involvement – comprehensive planning, adaptive management strategies, interdisciplinary collaboration, robust monitoring and evaluation, and high levels of technical knowledge were all fundamental to the REP's success.

The REP demonstrates the potential of collaborative conservation efforts on inhabited islands. While the authors do not claim to have all the answers - the lessons in this report are aimed to assist conservation practitioners elsewhere when planning similar ground-breaking ecological restoration and regeneration projects.

Background

Location

Lord Howe Island (LHI; 1455ha) is a remnant volcano in the north Tasman Sea, situated 600km east of mainland Australia (31°S, 159°E – Figure 1) with a coastal mix of beaches and cliffs and a largely forested interior. The 11 km long, 2 km wide island contains low hills in the north, separated from two precipitous 800m summits in the south by the Settlement and farmland. The Lord Howe Island Group (LHIG; Lord Howe Island and surrounding islets) is a World Heritage listed area due to its outstanding natural and scenic values.

Figure 1: Location and satellite view of Lord Howe Island Group (LHIG). Earthstar Geographics | ESRI © OpenStreetMap contributors, TomTom, Garmin, Foursquare, METI/NADA, USGS.

Human Occupation

Humans had never occupied the island before its discovery in 1788, and settlement in 1834. The Settlement covers roughly 15% of the island with 445 permanent residents in 2021, an increase from the 382 in 2016 (Australian Bureau of Statistics, 2021; Australian Bureau of Statistics, 2016). Tourism is the major industry, with 400 tourists permitted on the island at any one time. LHI is administered by the Lord Howe Island Board (LHIB) - a NSW Government Statutory Authority under the *Lord Howe Island Act 1953* on behalf of the residents. The LHIB undertakes many local and state government functions and services, as well as management of the island's terrestrial natural values. All land on LHI is Crown land, with residential, commercial and government property leased or occupied through the LHIB.

Culture

Contributed by Sally Montgomery

The resident population of Lord Howe Island is a community which holds deep connections to the Island and whose cultural values need to be acknowledged. The cultural history, values, and forms of social relation on Lord Howe Island are distinct from the mainland – shaped by the Island's unique history (and prehistory), as well as its isolation and size. These contextual social factors should be understood and recognised in relation to The Lord Howe Island Rodent Eradication Project.

Many Island people have long, multi-generational connections to Lord Howe Island. These connections result in strong ties to and association with the Island. For many people, belonging to the Lord Howe Island community is a key aspect of identity, and the Island as a whole is understood as 'home'. Residents who have moved to the Island from elsewhere also, over time, develop deep connections to the Island, cultivating knowledge and care of Lord Howe.

The Island community is highly engaged with environmental-management decisions and plans made on the Island. This is a result of the intimate knowledge Island residents have of the environment, the cultural values of custodianship and responsibility felt, the economic interest held (for example in the tourist industry), as well as the proximity with which people live in relation to key areas of the Island environment. The lives of the Lord Howe Island community are inextricably linked to the environment and as a result are acutely affected by management programs implemented.

The community, past and present, has also played an important role in the preservation of the Island. Care for, and involvement in, the environment has been an enduring feature of the social history of Lord Howe. In particular, the history of rodent control is a significant part of the social history of the Island as the next section describes in brief.

Rodents on Lord Howe Island

Only two native species of land mammals, both microbats (one now extinct), have been recorded on LHI (Eldridge, et al., 2017). The absence of native mammals, particularly native rodents that are present in other regions, was a double-edged sword for LHI – local native species had not experienced the pressure of small mammals, so introduced rodents had devastating impacts, but it does significantly reduce the off-target impacts of a potential eradication operation.

Mice (*Mus musculus*) invaded LHI around the 1860s, and black rats (*Rattus rattus*) arrived in 1918 during the grounding of the SS *Makambo*. The rats irrupted to plague numbers within two years (Hindwood, 1940). Rats have since been implicated in the extinction of five endemic bird species, 13 invertebrate species and two plant species (Wilkinson & Priddel, 2011). Today, LHI residents express concern for the environmental, economic and social impacts of both rats and mice (Figure 2) – with environmental impacts being of the most concern (Lord Howe Island Board, 2024).

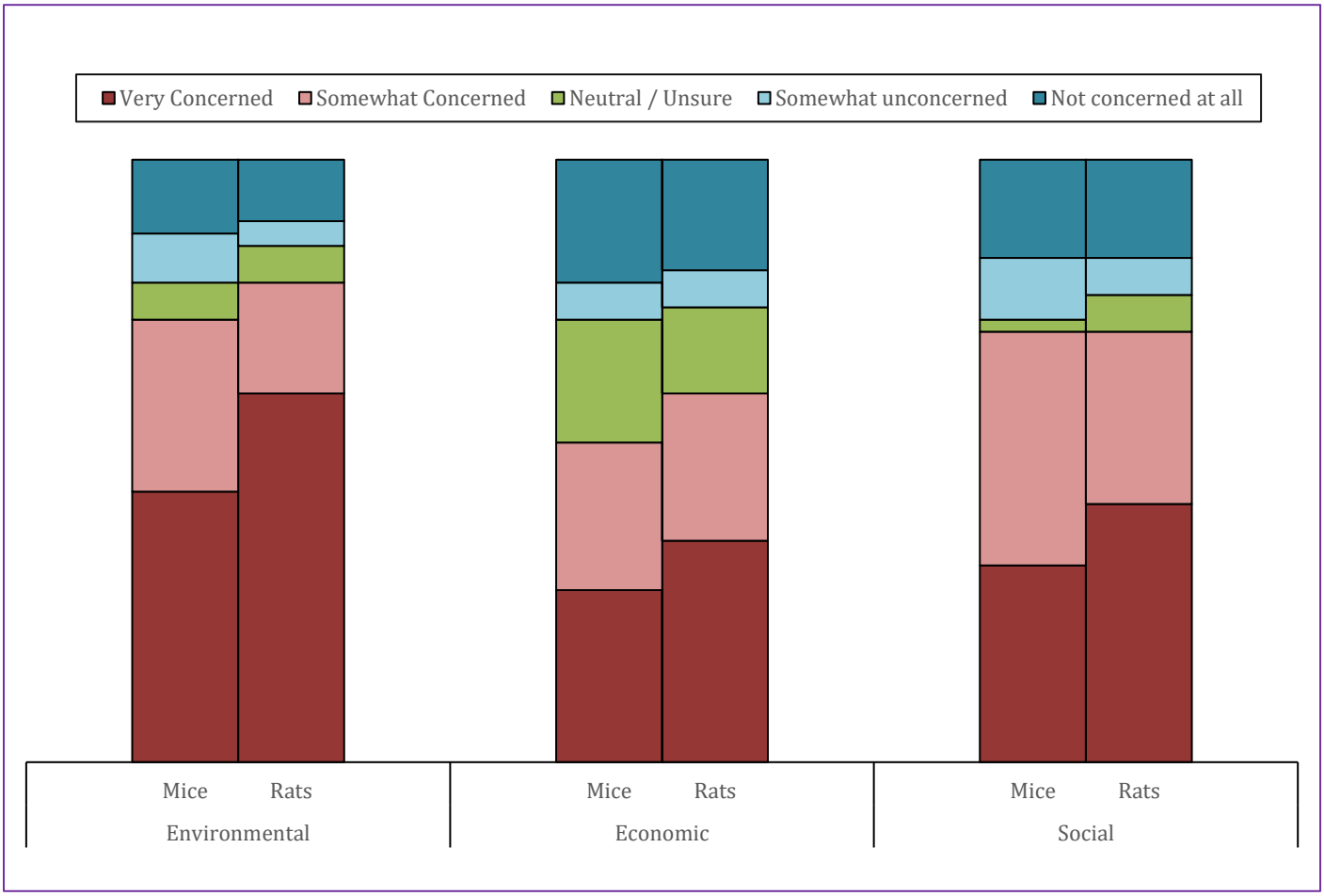


Figure 2: Level of Concern among LHI Community members for the threat of rodents - by LHI values and rodent species (Lord Howe Island Board, 2024).

This concern for protecting the values of LHI has been evident since rats landed on Lord Howe, with local residents attempting control of rodents through techniques which included shooting, dogs, bounty schemes (Figure 3) biological control (through the introduction of owl species) and baiting. This control focused on reduction in rodent numbers to reduce damage to the kentia palm (*Howea forsteriana*) industry and residents' gardens, orchards and homes. This ongoing control of rodents was a sub-optimal option for the island, as it did not remove all the rodents nor stop their continuing damage to human infrastructure, food crops and the palm industry.

An eradication of rodents and effective biosecurity could remove the need for this ongoing control and remove all the pest animals in perpetuity, stopping the continuing damage to the island economy – as well as removing a key ecological threat and promoting recovery for a wide range of threatened species.

Figure 3: Rodent tails were collected by rat hunting parties and could be exchanged for a reward. Photo courtesy of Lord Howe Island Historical Society and Museum.

Feasibility of Eradication

The effectiveness of the existing control program was evaluated in 1999 (Billing, 1999). Four options to improve effectiveness and minimize cost were considered; (1) No control; (2) Periodic control; (3) Sustained control; (4) Eradication. The review concluded that sustained control was the most appropriate option due to several major practical problems for eradication, including human visitation/occupation, abundant resources in the settlement area, the inaccessibility of vast areas of the island and associated considerable costs.

In contrast to this, rodents had been successfully eradicated from New Zealand islands for 2-3 decades (Russell & Broome, 2016) including on publicly accessible islands (Veitch, 2002; Hector, 2011) larger than Lord Howe Island with steep slopes and cliff-faces. The success of these eradications was partially attributed to the development of 2nd generation anticoagulant rodenticides. These rodenticides were effective against the anticoagulant-resistant rodent populations (Hadler & Shadbolt, 1975) that appeared due to wide-ranging use of 1st generation anticoagulants such as warfarin – which was used extensively on Lord Howe Island from 1986 (Saunders & Brown, 2001). The use of helicopters for the aerial broadcast of these rodenticides coupled with flight tracking using GPS, was the fundamental change that allowed for rodent baits to be safely and accurately broadcast across large areas of remote and rugged terrain.

Eradication of rodents on LHI was first proposed in 2001, where the LHIB declared its in-principle commitment to the concept (Leaman, 2001). A feasibility study (Saunders & Brown, 2001) undertaken by the Endangered Species Recovery Council concluded that the removal of rodents from LHI would bring considerable benefits for biodiversity and that eradication was technically feasible. However, as there were inherent risks that needed to be managed, a detailed Eradication Plan would need to be prepared, and the community would need to be consulted. The authors also suggested that in the long term the costs of an eradication were likely to be less than the then ongoing control, but likely did not fully consider the costs associated with ongoing biosecurity needs.

A more detailed cost-benefit analysis was undertaken in 2003 (Parkes, Ruscoe, Fisher, & Thomas, 2004) - which found eradication to be the most financially viable option available – with the cost of eradication being offset within four years by the reduced control costs and increased palm seed production alone. Eradication would also have significant benefits for biodiversity, although the financial benefits of this were difficult to quantify, as were the social costs/benefits.

Parkes et al. also raised concerns around the non-target impacts of an attempted eradication. To address this issue, and answer other questions around technical feasibility, non-toxic bait trials were conducted on the island in 2006 and 2007 (Lord Howe Island Board, 2007; Lord Howe Island Board, 2008). These studies established methodologies for technical aspects of the eradication, including bait size, palatability and broadcast techniques, as well as finding that Lord Howe currawongs (*Strepera graculina crissalis*) and Lord Howe woodhen (*Hypotaenidia sylvestris*) were particularly vulnerable to ingesting toxic baits and secondary poisoning, and would require captive management during the eradication operation.

Eradication Planning

With an eradication plan in its formative stages, there was a need to take a strategic approach to communication and the dissemination of information to multiple stakeholders, particularly the LHI community. It wasn't the first time a rodent eradication had been mentioned to the community - extensive community consultation was conducted during the preparation of the Lord Howe Island Biodiversity Management Plan (Department of Environment and Climate Change (NSW), 2007), which included the concept of an eradication. The LHIB developed a Communication Strategy (Lord Howe Island Board, 2008) to raise awareness of the need for, and feasibility of, a rodent eradication on LHI – as well as to allay concerns from local residents. It was also used to generate and maintain financial, logistical and community support for an operation.

The Draft Lord Howe Island Rodent Eradication Plan (Lord Howe Island Board, 2009) was prepared to guide the planning and implementation of a program to eradicate rodents from the Lord Howe Island Group. The plan drew on the 2001 feasibility study, the 2003 cost-benefit analysis and was peer reviewed by the Island Eradication Advisory Group (IEAG) of the New Zealand Department of Conservation; the Invasive Species Specialist Group (ISSG) of the Species Survival Commission of the World Conservation Union; the Worldwide Fund for Nature, Australia; Birds Australia; Landcare Research (NZ) and Professor Tim Flannery.

The primary focus of this Draft Eradication Plan was the logistical and technical aspects of the eradication, including approvals/preparations, bait type/size/distribution, timing, risk management and program evaluation. In addition, there were recommendations for consultation and communication with the local community. It highlighted that the support of the local island community was integral to the program's success and would need to continue throughout the life of the program.

The proposed approach involved four distinct stages:

- **Pre-stage:** Public exhibition
- **Stage 1**: Completion of all planning, community consultation and preparations for the eradication operation (scheduled from July 2012 – June 2015).
- **Stage 2:** Implementation of the baiting strategy including captive management and post baiting monitoring (scheduled from July 2015 – Jan 2016).
- **Stage 3:** Monitoring of the environmental outcomes of the baiting operation (commence 2012/13 – 2018).

The Plan was put on public exhibition from the 30 October – 27 November 2009 and received 83 submissions from the public, including the LHI community, government and non-government organisations and individuals (Lord Howe Island Board, 2010). There was no information provided in submissions that warranted a completely different approach to the Draft Eradication Plan, but there were several issues that required minor changes, clarifications and corrections. The most frequently raised issues centered around non-target impacts during the proposed operation

(30%). Other commonly expressed concerns were around potential health impacts, social concerns and practical issues with the methodology (Table 1).

Notably, all 39 submissions opposing the plan were from LHI residents, organisations acting on their behalf, or had strong links with LHI community members. Of the 33 submissions supporting the proposal, 11 came from LHI and four came from scientific representatives with experience in rodent eradication. The four submissions offering in-principal support all originated from LHI.

Table 1: Summary of issues raised in public submissions to the Draft Eradication Plan (Lord Howe Island Board, 2010) – note that not all issues raised were negative – ***positive items raised are highlighted in bold.***

Issue	Broad Theme	No. of submissions	% of submissions
Non-target impacts	Ecological	25	30.1%
Human health concerns	Social	18	21.7%
More consultation required	Social	18	21.7%
Tourism impacts	Social / Economic	16	19.3%
Marine impacts	Ecological	14	16.9%
Economic impacts	Economic	13	15.7%
Eradication will deliver environmental benefits	**Ecological**	**13**	**15.7%**
Proposed eradication too risky	Practical	10	12.0%
Children's health concerns	Social	9	10.8%
Threat posed by negative media associated with eradication	Social	9	10.8%
Question rodent impacts	Ecological	8	9.6%
Feasibility – it won't work	Practical	8	9.6%
Captive management issues	Practical	7	8.4%
High cost of operation	Economic	7	8.4%
Use of divers to remove bait	Practical	7	8.4%
Rodents have significant impacts	**Ecological**	**7**	**8.4%**
Don't support aerial baiting	Practical	6	7.2%
Peer review process flawed	Social	6	7.2%
Quarantine efficacy – new protocols to prevent reinvasion	Practical / Social	6	7.2%
Expand current control programme	Practical	5	6.0%
The eradication is an experiment	Practical	5	6.0%
Need to work with the community to gain support	Social	5	6.0%
Distrust of LHI Board	Social	5	6.0%
Overall support the plan		33	39.8%
Overall in-principle support of the plan		4	4.8%
Overall oppose the plan		39	47.0%
Overall support or opposition not expressed/undecided		7	1.2%

In the following years, a number of studies were undertaken to help allay some of the concerns raised by submissions, including a Human Health Risk Assessment (Toxikos, 2010) and captive management trials in 2013 (Taronga Conservation Society Australia, 2014), neither of which identified any significant issues, but did provide detail on the proposed approach. With the technical feasibility confirmed, non-toxic bait trials completed in 2007 and 2008, community engagement underway, the draft eradication plan approved, and non-target impacts considered manageable, sourcing funds commenced.

Funding was received in 2012 for planning and implementation of the Lord Howe Island Rodent Eradication Project - A$4.5 million from the Federal Government's Caring for Our Country Program (now National Landcare program) and A$4.54 million from the NSW Environment Trust. Once funding was received, multiple advisory groups, a monitoring program, and a project management structure were established. The group and staff roles are summarised in Figure 4 and Table 2.

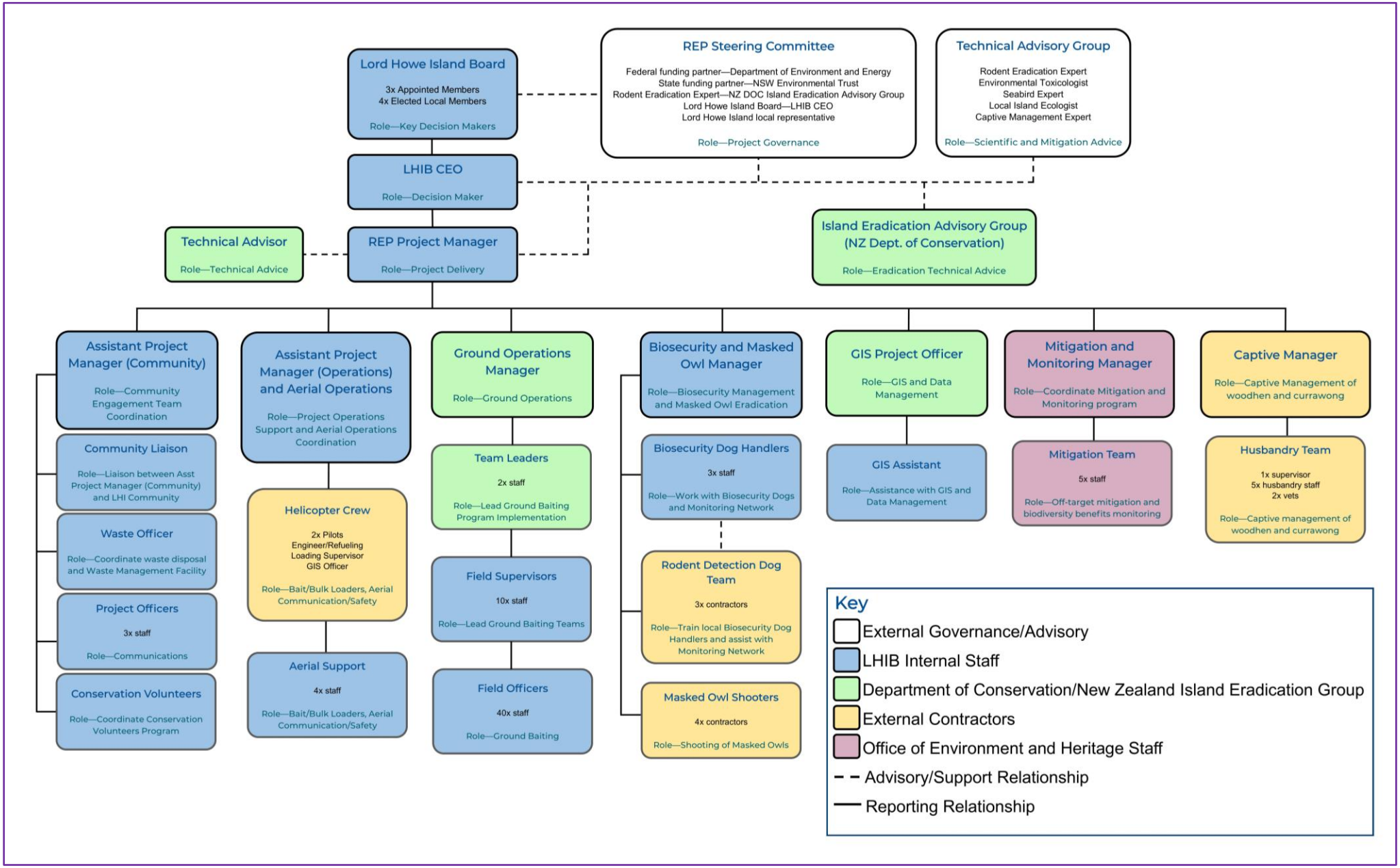


Figure 4: Governance, Support and Staffing Structure for the LHI REP.

Table 2: Suggested timing of staffing requirements for the LHI REP. NB; this was not the actual staffing resources for this project, rather the suggested timing of roles with the benefit of hindsight. Refer to Figure 3 for the interaction between these roles.

		Employment Period (years)												
		Pre-Eradication										Implementation	Post-Eradication	
Role	**Number of staff**	**-5**	**-4.5**	**-4**	**-3.5**	**-3**	**-2.5**	**-2**	**-1.5**	**-1**	**-0.5**	**Operational Period (6 months)**	**0.5**	**1**	**Ongoing**
Project Manager	1														
Assistant Project Manager (Community)	1														
Assistant Project Manager (Operations)	1														
Community Liaison Officer	1														
Communications Project Officer	3														
Technical Advisor	1														
Operations Manager (Ground)	1														
Operations Manager (Aerial)	1														
Aerial Support	4														
Compliance Officer / Legal expertise	1														
Livestock Coordinator	1														
Waste Manager	1														
Stores Person / Procurement Support	1														
Human Resources / Administrative Support	2														
GIS and Data Officer	1														
Assistant GIS and Data Officer	1														
Biosecurity Team Leader	1														
Biosecurity Officer	4														
Field Team Leaders	2														
Field Supervisor	10														
Field Officer	40														
Volunteer Field Officer	20														

Community Consultation and Further Analysis

The feedback received during the consultation on the preliminary eradication plan revealed diverse opinions regarding the eradication of rodents. The proposed eradication program, which planned the application of brodifacoum by aerial distribution and the use of bait stations, resulted in strong opinions both for and against its implementation. Acknowledging the community's varied perspectives, the LHIB opted to suspend the proposed eradication in early 2014 and revisit the community for discussions on available options.

Elton Consulting was contracted to conduct community consultation visits to Lord Howe Island between July 2014 and February 2015. They engaged with residents individually and in open sessions to discuss rodent control and potential eradication, using an incremental approach to understand the community's response and identify factors for active engagement in evaluating alternatives.

Several issues, such as human health, business, tourism, and environmental impacts, were identified and various options considered. The "do nothing" option was generally dismissed, given the consensus that rodents posed a problem, and the island would be better off without them, but preference was for ongoing rodent control rather than their eradication. In May 2015, an options paper was distributed to all people registered on the electoral roll for LHI, together with an anonymous survey asking the residents about their preference between the following:

1. Retain and expand the current management program.
2. Move to the planning and approvals stage of an eradication program.

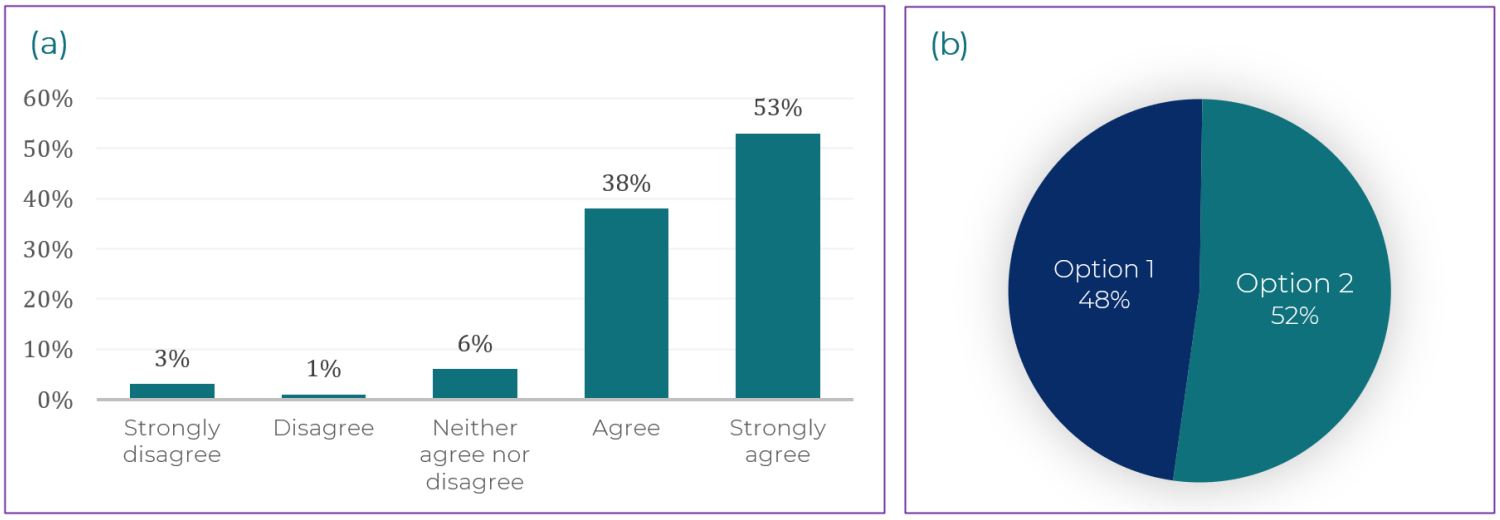


Figure 5: (a) Responses to LHI Community Survey on whether the rodent problem on LHI needs to be addressed (n=200), and (b) results of the choice between (1) Retaining and expanding the current management program, and (2) Move to the planning and approvals stage of an eradication (n=204) (Elton Consulting, 2015)

A total of 212 respondents participated in the survey (Elton Consulting, 2015) – representing 71% of the people listed on the LHI electoral roll. While 91% of respondents agreed that the rodent problem on LHI needs to be addressed (Figure 5) only 52% expressed a preference for Option 2.

This highlighted the division in the community with the program at the time, despite strong agreement on the need for rodents' removal.

Survey questions revealed continuing unease around human health, impacts on the natural environment (including non-target impacts), and impacts on tourism and economy, demonstrating that the community still had many genuine concerns at this stage. Despite these concerns, the LHIB moved towards the project planning and approvals phase in May 2015, reflecting the slight majority view, but agreeing to undertake an additional independent Human Health Risk Assessment (NSW Chief Scientist and Engineer, 2017) and further economic evaluation (Gillespie Economics, 2016). These reports concluded that the Rodent Eradication Project (REP) would provide net economic benefits for the people of LHI and Australia, which was considered a ground-breaking study, later peer-reviewed and published in the journal of Ecological Economics. However, aspects of the costs and benefits of an eradication, including ongoing biosecurity costs, were overlooked. The Human Health Risk Assessment was commissioned to alleviate perceived lack of independence of the Toxicos report. The LHIB deliberately stayed out of this process, with Office of the Chief Scientist and Engineer establishing an expert panel and two Community Working Group members participating in scope development and tender assessment. This study was a key step in the process for resolution and concluded that no adverse health effects were expected for any individual as part of the REP, however not all community members accepted all findings of these reports.

It should be noted that while the initial stages of the eradication consultation were underway there were many other complex issues that the LHI community was asked to engage with. Many consultation pieces or inefficient consultation can lead to consultation fatigue, where people feel like they are approached more and more often to participate, but see little return on the time and energy they give up to do so, and may become cynical about the value of consultation (Richards, Carter, & Sherlock, 2004). The LHI community was increasingly being consulted, and asked to comply with, a broader range of both local and external programs and initiatives including improved quarantine compliance, a new Permanent Park Preserve Plan of Management (Lord Howe Island Board, 2010), a Multi-Species Biodiversity Management Plan (Department of Environment and Climate Change (NSW), 2007) and the establishment of a new Marine Park.

A pertinent example was the multimillion dollar Weed Eradication Program which was a major initiative requiring significant community input and support – particularly due to the proposed eradication of introduced cherry guava (*Psidium cattleyanum*) a species introduced and used extensively by the early settlers as a source of Vitamin C, becoming part of the cultural landscape of the island. While only a few locals continued the tradition of harvesting and cooking with guava (usually as a jam), it was a plant that retained significant ownership and cultural attachment in the local community. There was substantial consultation on the removal of this culturally significant invasive species, as well as consultation on compulsory inspections of leases as part of annual weed inspection programs. This program is just one example of other activities taking place at the time of the initial REP consultation, so it is highly likely that the LHI community were experiencing consultation fatigue during this time.

Implementation

Between 2015 and 2017 there was an enormous amount of work undertaken to progress the project to a stage where it was ready for implementation. This work included seeking approval for consents, ongoing community consultation, drafting of a communication plan, the design of the captive management facility, and establishing monitoring of baiting effects.

In September 2017 the LHI Board members, in collaboration with funding bodies, reached a final decision to move forward with the eradication project. After 15 years of planning this pivotal decision was supported by a comprehensive assessment of the project's technical, financial, and, to an extent, social feasibility. Despite a lengthy planning stage to get to this point, the two years from the final decision to implementation were immensely time pressured – but many hurdles could not be jumped until this point. Key considerations included the status of necessary consents, environmental safety, an additional independent Human Health Risk Assessment, social acceptability, budget constraints, technical viability, and the recommendation from the Steering Committee. The history, implementation and outcomes are summarised in Figure 6.

Several delays accumulated throughout 2017 to 2019 that very nearly terminated the project. These delays were associated with logistical, technical and permitting issues, along with contracting of senior management staff, bait and bait station procurement, ongoing community engagement and property plans, and development of GIS management processes for the ground baiting operation. With these delays, the operational stage began in 2019.

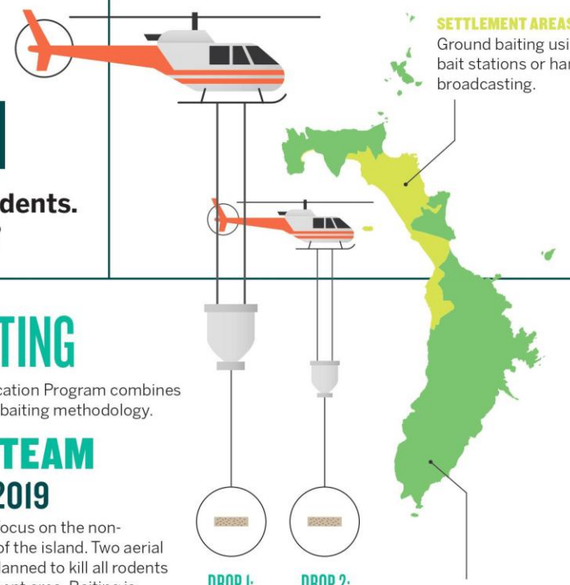
The implementation of the REP marked a world-first as the largest permanently populated island to attempt a full-scale rodent eradication. Given that a project of this scale had never been attempted before, there was no guide to refer to and there are many actions that could have been done differently. The project was ultimately successful, with the Success Check Report determining that there are almost certainly no rodents are extant on Lord Howe Island. However, there were elements of the project that could have been improved, and a different approach may have increased ownership of the program, reduced friction in the local community and cemented trust with island residents – resulting in a smoother operation.

The staff and project team members of the REP worked hard to advance this innovative, challenging, ground-breaking, project. As such, no conclusions or comments within this report are meant to be critical of any person involved with the Project. The complexities and challenges that were overcome stand as a testament to the passion and dedication of everyone involved. This report's objective is to outline the problems faced, how they were resolved and recommend actions for future eradications on inhabited islands, so they may avoid the considerable delays, cost overruns and challenges that dogged the LHI REP.

This document attempts to summarise the lessons learned during the implementation of this project under several key themes. A summary of these lessons can be found in Appendix 1. While many lessons will be specific to this program, it is hoped that many recommendations can be applied to future eradication operations elsewhere, as well as for projects on LHI.

LORD HOWE ISLAND RODENT ERADICATION PROGRAM

The largest populated island to undertake a full scale eradication of rodents. What does it take for an operation of this magnitude to be successful?



LESS THAN **1.2KG** BRODIFACOUM
The total bait application of cereal pellets will contain a total of 1.2kg of the active ingredient brodifacoum.

28 000 BAIT STATIONS
Used across the settlement area.

2100ha OF SURFACE AREA TO BE BAITED

1 PROBLEM IDENTIFICATION

2001

Mice and rats are responsible for the extinction of at least 5 endemic bird species and 13 invertebrate species since 1918. Inaction will threaten the unique biodiversity values on which World Heritage listing is based.

150 000 MICE **210 000** RATS

House mice (*Mus musculus*) arrived on Lord Howe Island before 1860. Black rats (*Rattus rattus*) were introduced in 1918 when the ship *SS Makambo* ran aground.

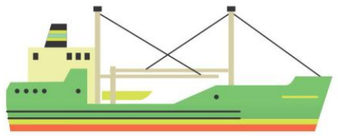
70+ THREATENED SPECIES IMPACTED BY RODENTS

Including the world's rarest insect, the Lord Howe Island phasmid. Thought to be extinct since 1920, it was rediscovered on a rodent-free island in the Lord Howe Island Group in 2001.

2 PLANNING, LOGISTICS & COMMUNITY ENGAGEMENT

SEP 2017–APR 2019

Located 775km off the coast of Sydney, Lord Howe Island's remote location means the project requires extensive planning and logistics management, in conjunction with broad and ongoing community engagement to ensure the greatest possible chance of success.



1 SUPPLY SHIP

Most of the equipment and materials needed for the project will be shipped by the *Island Trader*.

8 CORE PROJECT CREW

Responsible for project planning and logistic management.

3 BAITING

The Rodent Eradication Program combines aerial and ground baiting methodology.

AERIAL TEAM
JUN/JUL 2019

Aerial baiting will focus on the non-settlement areas of the island. Two aerial applications are planned to kill all rodents in the non-settlement area. Baiting is scheduled for winter to decrease the risk to non-target native animals.

DROP 1: 12kg/ha DROP 2: 8kg/ha

2 AS350 HELICOPTERS USING BAIT SPREADING BUCKETS

Each helicopter is equipped with a flight line Global Positioning System (GPS), recording accurate flight lines to ensure bait is applied with 100% coverage. Use of deflector buckets will minimise bait in the marine environment.

2 AERIAL BAIT APPLICATIONS
3–5 days each, 14–21 days apart. Scheduled for June/July 2019.

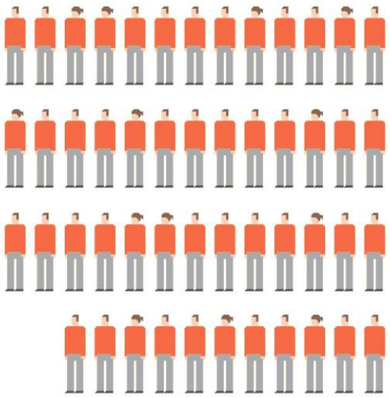
2 HELICOPTER PILOTS
Highly skilled with experience flying in challenging conditions.

8 AERIAL SUPPORT CREW
One helicopter engineer, one GIS officer, one loading supervisor, and five bait loaders.

GROUND TEAM
MAY–OCT 2019

Bait stations will be placed throughout the settlement area, with hand broadcasting in areas between bait stations and aerial areas.

50 GROUND BAITING CREW
To place bait stations, monitor bait stations and to hand broadcast bait.

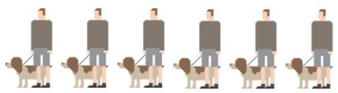


4 MONITORING & CAPTIVE MANAGEMENT

APR 2019–AUG 2021

6 CAPTIVE MANAGEMENT CREW
Up to 85% of woodhens and 50-60% of currawongs will be housed during baiting by the Taronga Zoo team, who provide specialist care for the birds during the monitoring phase.

6 SPECIALLY TRAINED DOG TEAMS
Two permanent biosecurity dogs and their handlers will monitor rodent activity. Specially trained rodent detection dogs and their handlers will also be used after the baiting.

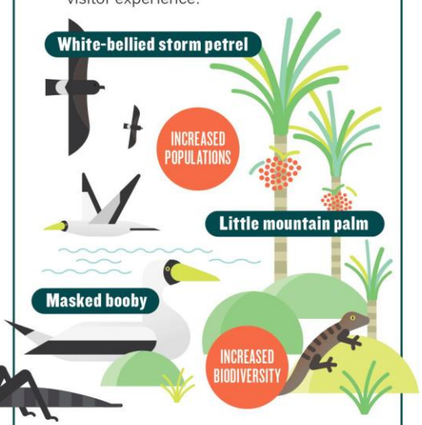


Intensive rodent monitoring will occur for two years, followed by ongoing biosecurity monitoring. If no rodents are detected two years after the initial eradication the project will be deemed a success.

5 OUTCOMES

AUG 2021

- Increased biodiversity.
- Enhanced world heritage values.
- Removal of rodenticide from Lord Howe Island permanently.
- Removal of domestic rodent impacts and related health concerns.
- Increased numbers and breeding success for birds such as the Kermadec petrel, masked booby and white-bellied storm petrel.
- Increased seeds and seedlings for numerous plant species including the critically endangered little mountain palm.
- Recovery of endemic ground lizards and invertebrates such as land snails.
- Reintroduction of the world's rarest insect, the Lord Howe Island phasmid.
- Long term benefits to tourism and the island's economy through improved visitor experience.



TIMELINE

PROGRAM BUDGET: $10.5 MILLION

PRE-2017

1 2001–2004
Feasibility study.

2007–2012
Initial trials.

2012
Funding received.

2012–2017
Additional studies and community engagement.

2017

2 SEP 2017–MAY 2019
Recruitment, planning and operational logistics.

2018

3 APR 2019
Woodhen and currawong capture.

MAY–OCT 2019
Ground baiting.

JUN/JUL 2019
Aerial baiting.

2019

4 MAY–NOV 2019
Environment and targeted health monitoring.

AUG 2019
Masked owl eradication.

2020

SEP–OCT 2019
Currawong (staged) release.

NOV 2019
Woodhen release.

2021

JUL 2019–JUL 2021
Rodent monitoring and biodiversity benefits.

AUG 2021
Final detection and rodent monitoring.

POST-2021

5 AUG 2021
Outcome of project declared.

POST-2021
Long term biodiversity monitoring over 3–10 years, plus ongoing rodent and biosecurity detection.

LORD HOWE ISLAND RODENT ERADICATION PROJECT

GREEN GLOBE AWARDS 2018 WINNER

PROGRAM PARTNERS

Australian Government National Landcare Programme
NSW GOVERNMENT NSW Environmental TRUST
United Nations Educational, Scientific and Cultural Organization · Lord Howe Island Group inscribed on the World Heritage List in 1982
TARONGA ZOO

INFOGRAPHIC BY MIKE ROSSI / MICROGRAFIK.COM

Figure 6: Setting the scene: infographic summarising the LHI REP – history, implementation, and early outcomes.

Lessons Learned

1 Community

1.1 Engagement and Support

Desired Outcome:

The project's success and sustainability are bolstered by strong local community support, early and effective implementation of a community engagement plan, and prioritising genuine, meaningful engagement throughout all phases.

Actual Outcome:

The project was divisive in the LHI community – gathering considerable support, but also facing strong opposition.

A failure to understand the scale of community engagement needed, distrust in the robustness of the science behind the project, as well as fragmented and controversial engagement over a long time-period contributed to dissatisfaction and resistance. The development of a Communications Plan, having genuine conversations with residents, hiring local team members, and use of community champions were critical to the project's success.

Any project that may affect people, even in a small way, requires robust community support to succeed – and this is of particular importance for an eradication operation on a remote inhabited island. When community engagement is undertaken correctly, the local community can be the biggest ally to a project – but to achieve this, the idea for the project needs to come from the community, with it not seen to be imposed on them. Indeed, on reflection, locals have commented on how a different name, something with a more positive tone along the theme of 'Protecting Paradise', may have helped when seeking the community's support and ownership of the project.

As the largest inhabited Island to undertake a wide-scale rodent eradication there were many lessons learned throughout the process. Community division on the methodology (particularly aerial broadcast of bait) caused a great deal of angst in the small community which could have been avoided through a better understanding and integration of the community's social values into early consultation and planning. The Lord Howe Island community had been undertaking rodent control for almost 100 years by the time the REP was implemented in 2019 from collecting tails in the 1930's to baiting ~10% of the island until 2016 in preparation for the REP.

The LHIB developed a Communication Strategy in 2008 to raise awareness of the need and feasibility for rodent eradication on Lord Howe Island, and to generate and maintain financial, logistical and community support for an operation (Lord Howe Island Board, 2008). The plan was repeatedly revised as a result of the consultation process. The International Association for Public Participation (IAP2) have designed the Public Participation Spectrum (International Association for Public Participation - IAP2, 2023) to assist with the selection of the desired level of participation in a public participation process. Along this spectrum, the original 2008 Communications Strategy was focused on informing the community, whereas further involvement, collaboration and even empowerment, particularly in these early stages, may have been more effective for the project – as well as being transparent about what decision-making power the community has from the outset.

The 2008 plan was revised multiple times, with a Community Liaison Group in place by 2013 that undertook workshops, with engagement consultants and experts providing advice along the way. A Community Working Group (CWG) was in place from 2015 onwards, and individual-level consultation was undertaken from 2015-2019. This strategy outlined an approach to provide clear lines of communication between agencies, generate and maintain support from external stakeholders, and how to communicate with the LHI community on the 'Why, When and How' of an eradication – aiming to raise awareness among local residents, obtain feedback, allay concerns and generate support. During this engagement process there were two principal risks beginning to arise from the resistance to the project in the local community;

I. Gaps in baiting coverage due to access restrictions to properties, and
II. Active resistance and obstruction to the project in an attempt to derail it.

The Draft Eradication Plan was posted for public exhibition (see *Eradication Planning* above), receiving 83 submissions. Concerns were expressed about non-target impacts, human health, and social issues. Notably, all opposition submissions came from local residents, highlighting the importance of community involvement in the success of the project – and the need to engage effectively with the community throughout the entirety of the program rather than telling the community what was going on and planned. In 2015, 14 years after the program was first slated, a LHI referendum (See: Community Consultation and Further Analysis) highlighted the division in the community to the program. However, by 2016, the Public Environment Report (Environmental Protection and Biodiversity Conservation Act, EPBC, Approval) had 128 submissions with 118 supporting and 10 opposed to the program – but these came from a mixture of residents and mainland Australians. A voluntary Community Survey in 2024 (Lord Howe Island Board, 2024) found that 78% of respondents were in support of the concept of eradicating rodents from LHI.

Consistent messaging is extremely important in any community engagement, and this was a key issue for the REP. Engagement with the LHI community stretched over a decade and was disconnected and at times controversial, with the execution of community engagement efforts falling short at times, fueling dissatisfaction and resistance. Changes to messaging, key project elements and team in the 10-year planning process prior to the program led to distrust in the robustness of the scientific research that underpinned the program. A 2024 Community Survey

(Lord Howe Island Board, 2024) found that 56% of respondents thought they had little or no influence over project technical decisions. In the time leading up to implementation, there was a fine line between instilling confidence in the scientific rigour of the process and admitting that, as the largest inhabited island to ever attempt to eradicate rodents, there was an experimental element to what was being proposed. Further to this, early in the community engagement journey a key team member was said to have assured the community that if there was not 100% support that the project could not go ahead, which was obviously not the case. This caused immense frustration during negotiations with community around property access and highlighted the need for clear communications planning prior to community engagement. Similarly, the wider significance of the project (it had support from national and international conservation groups such as WWF, RSPB, ISSG of the IUCN, Zoos Victoria, and the Threatened Species Scientific Committee) may not have been effectively disseminated to the community which may have given the REP a broader context and alleviated some concerns.

Despite the opposition or indifference at the start of the implementation phase of the project before 2018 - the Assistant Project Manager (Community) generated a considerable level of community support through strong and effective communication and genuine engagement with community members. The following strategies contributed to the program's eventual success:

- Having the right people, conservation practitioners with significant Community engagement experience living on the island for extended periods to build trust and rapport.
- A Communications Plan detailing strategies to ensure relevant information is received by all community members.
- A dedicated Community Engagement Team to give timely responses to community concerns via phone, email and verbally.
- Development of an effective process for property access.
- One-on-one community member conversations.
- Community Champions – a group of influential and respected community members that were positive about the project and circulated accurate information within the community.
- Education campaigns, sessions, and materials.
- Hiring local team members who bring local knowledge of property, local politics, and community relationships.
- "Householders" (letters to all residents) and informal conversations with REP staff were seen as the most valuable modes of communication by residents in a 2024 Community Survey (Lord Howe Island Board, 2024)

The REP ground baiting operation relied heavily on community participation, with almost daily private property checks, including internal stations in all houses and structures. Use of a local workforce made this process more palatable to the community and was a significant learning of the project. During the operational phase the REP employed over 20% of the local population of 18-64-year-olds (63 people), making up 45% of the project workforce with the majority of households on the island being represented by at least one team member. The success of the Rodent Eradication Project is a community legacy that will be felt for many generations.

Lessons Learned:

- Community engagement is a key pillar of project planning and feasibility. Failing to effectively execute engagement risks project failure through project compromises arising from lack of support or active resistance.
- Although the likelihood of achieving complete consensus for an eradication in an inhabited area is unrealistic, prior to any actions to proceed with an eradication a social impact plan and community engagement plan need to be developed and implemented.
- Technical and social feasibility are equally weighted in inhabited island eradications. Without understanding and planning the social component, implementation of a technical project within an unprepared community environment leads to significant technical compromise and damage to key community relationships.
- Conduct a comprehensive and empathetic consultation process using trained facilitators, eradication expertise and local guidance. The outcomes of this process should be used to inform the project options development, feasibility, project management and eradication planning. There is a need to consider very long lead times and budget implications of this.
- Community engagement team members should be embedded in the community for an extended period prior to the project or sourced from the local community.
- The community needs to be part of the exercise whereby they carefully consider the goal to be achieved and how to get there most effectively. Development and encouragement of the necessary level of community support and nurturing community champions is a crucial element of the Plan.
- Failure to identify social issues early in the planning process may result in technical compromises during the implementation phase – potentially creating delays, risk and additional costs for the project.
- If the eradication does proceed, the community consultation should influence the way it will be implemented. This information should guide the development of Property Access Plans – or an overarching Land Access Plan for larger islands where single-property-based plans are not appropriate.
- Where a sufficient level of community support is not attained after a suitably comprehensive and effective community consultation program, then consideration needs to be given as to whether to proceed. This will likely be one of the most difficult decisions made during the entire program.
- Plan to employ a Community Relations Officer(s) in the community team to provide a variety of regular information packages and updates prior to, and throughout, the operation.
- Provide a consistent stream of easily digested information to keep the community well-informed and reduce the likelihood that misinformation will spread.
- Keep community champions regularly updated on pertinent project information. This allows them to use their relationships within the community to answer questions and provide up to date details on the project through a trusted source.

1.2 Property Access

Desired Outcome:

All properties involved in the project grant access to all project staff.

Actual Outcome:

Despite initial resistance, by the start of the baiting program all properties had a Property Management Plan in place, but often with complex conditions.

Throughout 2017 and 2018 the Assistant Manager Community strived to get all leaseholders to agree to a Property Management Plan (PMP) for their properties. Without 100% bait coverage of the entire island to guarantee every individual rodent has access to bait, the operation would have failed. Property access was therefore crucial to the program's success. PMPs were a very well-founded and encompassing process to settle on property baiting arrangements and related conditions. There was continuous difficulty progressing these access plans as the terms for these plans were changing due to operational and permit changes. This process needed closer input from the operational team.

The PMP's were advanced in an empathetic manner and encompassed a combined education, negotiation and agreement exercise. By September 2018 121 of the 125 (97%) Leaseholders had an agreed PMP. The process was extremely complex, with some members of the community being actively opposed. It is important to note that 'property access' did not just include accessing outdoor areas of properties, but also involved accessing inside people's homes. Several leaseholders refused access on properties and inside dwellings for REP field staff. A variety of options to allow access were discussed with these leaseholders, including only allowing trusted acquaintances or relatives to apply bait, but many were rebuffed. In a 2024 Community Survey (Lord Howe Island Board, 2024), only 16% of respondents were unsatisfied with the PMP process during the REP – but several people raised communication around this process as an issue.

The final option contemplated was using a control order under the NSW Biosecurity Act 2015 which permitted access for as the REP was removing a biosecurity risk. This process took two years to get the Order in place and required Ministerial sign-off. The Control Order was based on an existing Order that the LHIB had for African big-headed ant removal. There was some resistance to this work and weed control well before the REP was into the implementation stage. The Department of Primary Industries, which administered the Biosecurity legislation, assisted with the small number of final leaseholder negotiations and in all cases an agreement was reached without needing to use a Biosecurity Control Order.

By the start of the baiting operation all properties had a PMP, some with specific conditions allowing access on predetermined dates and access requirements. This work significantly assisted the progress of the REP through to implementation. One-on-one engagement may not be possible for a larger population or would require a significant community engagement team.

Lessons Learned:

- Without complete bait coverage of the island, the eradication will fail. Property access therefore is crucial to the operations success.
- Property access is not a 'one size fits all' approach – genuine consultation will be required, and access needs to be managed at the individual property level.
- Do not underestimate the complexity of developing individual Property Management Plans. Allow plenty of time before the field operation to consult on these and adapt as project planning progresses. Aim to have all Plans in place well before the field operation begins.
- The Operations Manager needs to actively participate in the Property Management Plan process. It's crucial to thoroughly grasp the technical implications of any specific deviations, both on their own, within the broader program and in the context of other individual variations, before finalising plans.
- If the eradication does proceed, the community consultation should have genuinely influenced the way the project will be implemented. Use this information to guide the Property Management Plan process to negotiate and determine property access and baiting activities.

1.3 Economy

Desired Outcome:

The eradication operation and resulting biodiversity benefits will contribute positively to the local economy in the long-term and have minimal negative impacts in the short-term.

Actual Outcome:

The LHI REP contributed directly to the island's economy over the usually quiet 2019 winter period. In addition, ongoing economic benefits of the program are predicted to outweigh the costs.

In July 2003, the Board commissioned Landcare Research (NZ) to review the risks and constraints from different strategic options to manage rodents on Lord Howe Island. This was considered within a cost-benefit framework of two primary goals of protecting the palm seed industry and protecting biodiversity. The review (Parkes et al. 2004) determined that only three out of seven possible strategic options were considered appropriate for further investigation.

I. Eradication of rats or rats/mice.
II. Sustained control – maintain current level or vary the level according to priority protection areas.
III. Do nothing at all.

The cost/benefit scenarios were based on an annual gross income from the palm seed industry of A$1 million, which, in the medium-long term, made eradication the most financially viable option. The costs to eradicate ship rats and mice was estimated to be at least $813,000 – which would be offset within roughly four years by reduced control costs and increased palm seed production, eventually providing a net benefit over the then ongoing rodent control of A$5.7 million over 30 years (Parkes, Ruscoe, Fisher, & Thomas, 2004). This was a best guess based on examples from uninhabited islands, with no inhabited islands to refer to. Sixteen years later, eradication costs had increased significantly, even before the complications of an inhabited islands (e.g. greater biosecurity requirements) were included. If several technical aspects of the eradication could be addressed, the authors believed the benefits of an eradication outweighed the costs to the palm seed industry alone. Eradication of both species would also have significant benefits for biodiversity, although the financial benefits of this were difficult to quantify. The social costs and benefits were also difficult to quantify for this study – with the authors providing recommendations including gaining agreement from all households before attempting an eradication operation.

Further to this, while not directly related or initiated as part of the rodent eradication project, Destination NSW in partnership with the LHIB, the LHI Tourism Association and QantasLink, commissioned a LHI Visitor Survey in 2016 (Destination NSW, 2017). This survey provided valuable information for the project planning of the project by identifying visitor values.

The survey results that were relevant to the project found that the main drivers for holiday makers before visiting LHI were beautiful scenery (94%) and the natural environment, nature and parks (90%). Regarding LHI, the top two motivations to visit were escaping to a remote location (64%) and wanting to visit a World Heritage site (41%) (Destination NSW, 2017). As tourism is the largest industry on the island (Lord Howe Island Board, 2023), any potential impacts of the eradication attempt on these values needed to be carefully considered. To address this, and community concerns about the previous economic study, the LHIB contracted Gillespie Economics to undertake an Economic Evaluation comparing the effect of continuing with current control versus proceeding with the eradication, which were the two options presented in the 2015 community referendum. The key findings of this evaluation (Gillespie Economics, 2016) were:

- Investing in the Rodent Eradication Plan will create net benefits for Australia. It is justified on economic efficiency grounds.
- Rodent eradication would provide net benefits to the residents of Lord Howe Island and those living elsewhere in Australia.
- Rodent eradication would create net benefits by improving biodiversity, tourism opportunities and the profits of the kentia palm and fresh vegetable industry on Lord Howe Island.

Ongoing economic benefits of the LHI REP are primarily driven by improved biodiversity, including preventing further species extinctions, and increased tourism demand as a result. An increase in tourism demand could lead to:

- An increase in the market price for accommodation on LHI during peak tourism periods (even though no increase in visitation is possible because of the cap on bed availability). Accommodation providers and airlines would be the main beneficiaries during peak periods.
- An increase in visitation and in the market price for accommodation on LHI in off-peak tourism periods. All tourism providers i.e. accommodation providers, tour operators, food outlets and shops would benefit during off-peak periods.

As an additional tourism initiative during the REP, the LHIB in conjunction with LHI Tourism Association, launched an Eco Tourism centered campaign in January 2018, promoting Lord Howe Island based on its natural environment and conservation efforts, including the upcoming REP. This campaign targeted ‘environmental warriors’ and eco-travellers who wanted to make a difference whilst experiencing the natural environment that LHI has to offer. The strategy successfully attracted the new demographic – with over 350 registered volunteers participating in conservation activities, some tourism operators saw up to 33% increase in visitors over winter, and 28% of overall winter visitors indicating that they travelled specifically to assist with the REP. Additionally, many bed nights of accommodation were required for external baiting staff, and local

staff were paid for longer periods than usual, resulting in a flow-on spend in the community during the REP.

The REP would also remove the ongoing costs of rodent baiting, with the LHIB using five tonnes of Coumatetryl rodenticide a year, and many residents using stronger rodenticides on their property – saving individual residents money as well as the LHIB.

The studies and figures outlined above provided useful justification for the project, but the real-world economic costs and benefits of undertaking the project likely differ. For example, neither of the economic studies (Parkes, Ruscoe, Fisher, & Thomas, 2004; Gillespie Economics, 2016) fully considered the ongoing costs of ongoing biosecurity to maintain a rodent-free status. Currently, the LHIB spends around $2 million annually on recurrent biosecurity programs. However, it should be noted that rodents are not the only biosecurity threat to LHI that is addressed through the ongoing biosecurity program and regardless of whether the REP was implemented, the LHIB had committed to execute an improved Biosecurity Strategy (Gillespie Economics, 2016).

Additionally, in a 2024 survey of the LHI community, 71% of respondents believe the project and outcome has been beneficial for the LHI economy (Lord Howe Island Board, 2024) – quoting reasons including positives for the ecology of the island are positives for the residents and therefore the economy, less ongoing cost of rodent bait, and visitors having a more enjoyable experience without rodents present.

Lessons Learned:

- A Cost-Benefit Analysis for the eradication is a useful exercise if it demonstrates a positive return on investment. It gives justification for the project and will assist in gaining funding and support – but real-world economic benefits may be hard to estimate and quantify. It should consider different time and geographic scales and be revised over time if required.
- A Benefits Realisation strategy should be developed to capture benefits over time, informing evaluation and future projects.
- Ecotourism opportunities should be investigated for both assisting with the eradication in some way, and after the eradication has been completed.
- The economic cost of removing a key threatening process and recovery of over 70 native species has not been costed but should have economic justification on its own.

2 Planning and Resources

2.1 Permits and Compliance

Desired Outcome:

All consents are in place well before the field operation begins and all associated agencies understand and support the requirements of the operation.

Actual Outcome:

Late issuance of permits delayed the project progress, increasing cost and reducing trust within the local community.

Permitting issues contributed to significant delays in the project, and prior knowledge about what was required, and the timeframes involved, may have led to a smoother implementation. Permit applications essentially weren't started properly until after the 2017 decision to proceed. All applications were done by REP staff (a team of two at the time) and it may have been more efficient to have consultants prepare permit applications. In particular, the Australian Pesticides and Veterinary Medicines Australia (APVMA) and EPBC assessment processes took much longer than the statutory timeframes.

In some cases, processes occurring outside of the project and LHI impacted these delays. For example, the APVMA was in the midst of a controversial relocation to regional NSW (Australian Pesticides and Veterinary Medicines Authority, 2016) with only 9% of staff employed at the date of transfer accepting the offer to relocate, although some continued to work remotely (Matthews, 2023), and a disproportionate loss of critical regulatory scientist staff cohort – significantly reducing their capacity to do the work and give timely approval of permits. After the APVMA permit was finally approved, the permit was then withdrawn after being challenged in the Administrative Appeals Tribunal, which resulted in the re-application of the permit, adding a further delay.

Similarly, regulators were not familiar with the type and scale of the eradication operation and direct contact with the regulator by the community resulted in increased legal oversight of the program. Legal expertise early in the planning stages may have assisted with this process if lead times are clearly identified, and a compliance officer to ensure ongoing adherence to permits and reporting requirements are met.

The permits required for the LHI REP are listed below (Table 3). Different projects in other locations will have vastly different requirements - this is intended to act as a guide to display complexity only, not an exhaustive list of what is required a specific project.

Table 3: An outline of the permitting requirements for the LHI REP. NB; this is not an exhaustive list, nor is it intended to give exact details of what is required in other projects, it is merely to act as a guide to the complexity of what to expect.

Approval	Issuing Organisation
License to hold woodhen and currawong	Animal Ethics Committee
Permit to allow minor use and supply of an AGVET chemical for control of the Black Rat (*Rattus rattus*) and House Mouse (*Mus musculus*) on Lord Howe Island	Australian Pesticides and Veterinary Medicines Authority
Consent to import unapproved active constituents or unregistered agricultural or veterinary chemical products to be supplied and/or used in accordance with an APVMA permit	Australian Pesticides and Veterinary Medicines Authority
Height and horizontal distance to buildings	Civil Aviation Safety Authority
Pilot licensing	Civil Aviation Safety Authority
Aerial Operators certificate	Civil Aviation Safety Authority
Height over buildings: Provides exemption for height restrictions for aerial work operations	Civil Aviation Safety Authority
Permit to import conditionally non-prohibited goods	Australian Biosecurity
Notice to establish airside special event zone	Department of Home Affairs
Approval for a controlled action that will have or is likely to have a significant impact on any of the matters of national environmental significance – resulting in a Public Environment Report	Department of the Environment and Energy
Marine Parks permit (Ministerial)	Department of Primary Industries
Threatened species license to harm	Department of Primary Industries
Biosecurity Control Order	Department of Primary Industries
NSW Aerial Application Pesticide Control Order (AIR-1) Use of bait including aerial application and proximity to buildings	Environmental Protection Authority
NSW EPA Aerial Applicators Business license	Environmental Protection Authority
NSW EPA Aerial Applicators pilot license	Environmental Protection Authority
Environment Protection License (EPL): License to undertake helicopter related activities at LHI	Environmental Protection Authority
Waste classification and management if rodent carcasses or other non-target species carcasses are collected and transported to the mainland for disposal at an appropriately licensed facility	Environmental Protection Authority
Use, handling, storage and transportation of bait	Environmental Protection Authority and WorkSafe NSW
License to undertake actions that are likely to harm threatened species, populations or ecological communities or damage habitat	Office of Environment and Heritage
Capture and release of LHI Woodhens for the LHI REP	Office of Environment and Heritage
Capture and release of LHI Currawongs for the LHI REP	Office of Environment and Heritage
Landholder consent to access properties	Lord Howe Island Board
Landholder consent to access dwellings	Lord Howe Island Board

Lessons Learned:

- Early and ongoing active engagement with regulators is essential to discuss project, risks, mitigation and practicality of permit conditions. Getting DAWR, NSW DPE and EPA representatives to LHI increased understanding significantly.
- Waiting for permits to be granted can add significant delays to a project. Approvals preparation and statutory assessment timeframes should be built into schedule.
- Allow extra time for permits to be granted, and for any unforeseen permits that arise. Draft all permits at least 2-3 years prior to the operation to allow for review and approval.
- Legal expertise early in the planning stages would be greatly beneficial, as would the employment of a Compliance Officer.

2.2 Budget

Desired Outcome:

The operation is tracking within budget at all stages and includes a contingency that covers unforeseen hurdles.

Actual Outcome:

The LHI REP ran over-budget and did not have sufficient contingency in place.

The original sum allocated for the REP in July 2012 was A$9.5M derived from a budget compiled in 2009 by NSW National Parks and Wildlife Service (NPWS) research staff, based on the original eradication plan. Implementation of the project was planned for 2015. Funds were derived in equal parts from the Australian Government 'Caring from our Country' program, and the 'NSW Environment Trust'.

Approximately A$1.6M had already been spent by the start of 2016, with A$8.04M remaining. By April 2017, the projected budget spend to 30 June 2020 was A$10.7M, so a post-project deficit was already apparent. In March 2018 projected estimates at completion of the REP suggested a final overrun of approximately 4% of total project budget and drawdown of the funds was extended until the end of June 2019.

By November 2018 it was clear a budget shortfall was certain and significant efforts were underway to secure additional funds from a variety of sources. Additional funding was secured, but there was still significant overspend. A failure to properly and proactively monitor the costs as they were incurred was a significant issue, with the final cost of the project exceeding $15 million.

Several technical compromises throughout the project contributed to the overspend – including changes in the ground-baiting operation (see Theme 3: Technical Implementation) which alone ended up costing 7.5 times more than the original estimate, and the 10-years between compiling the original budget and project implementation led to an increase in eradication costs. Similarly, the extension in the program baiting also resulted in longer holding times for the captive birds and significantly increased costs.

The LHI REP was the most complex invasive species operation ever undertaken and presented several novel and highly complex operational components. It should be noted, that if the project stopped when the budget was depleted, the investment until that period would have been lost, and the chance of eradication likely missed.

Unforeseen cost over-runs such as this are not unusual for an eradication operation and may have been adequately catered for with some additional care and planning in the initial budget structure and support planning stage, including the need for an adequate contingency budget to compensate for unplanned changes. If not used, this contingency budget should be held for at least two years (after project success is confirmed) as an emergency response budget.

Lessons Learned:

- Budgets need to be routinely revised, and variations requested in advance.
- Spending needs to be proactively monitored throughout the program.
- Funding increases linked to revised budgets at project gateways as risks are understood and mitigated.
- Develop a comprehensive Feasibility Study at the outset, with a realistic and detailed budget with at least 50% contingency to allow for additional unexpected costs. This should be developed by experienced eradication and community engagement practitioners with a review of any previous inhabited island eradication budgets.
- Plan for delays and the associated additional costs these will incur.

2.3 Project Management, Planning and Governance

Desired Outcome:

The project is supported by associated Government entities and is effectively managed by people and agencies with good relationships and understanding of the program's complexity – including the needs of the community, permitting/legal requirements and technical implementation. There are clear channels of communication.

Actual Outcome:

The project suffered from a combination of regulatory, operational, and governance challenges. Proactive risk management, early planning, and improved communication with stakeholders could have significantly enhanced the project's development.

There are important lessons around project management and planning that can be taken from the LHI REP. Being the largest inhabited island community to ever attempt to eradicate rodents there was no guide on how to approach the project. With such a complex project that hadn't been attempted before it would be impossible to predict how it would run, and many parts of the project had to be adapted rapidly and unexpectedly.

An example of operational planning changes that contributed to the budget over-run occurred in early 2018. During a site visit in January 2018 led by the Ground Operations Manager, potential technical issues were identified regarding the original ground operation baiting plan, which involved a combination of hand-broadcasting and the use of bait stations throughout the Settlement. It was determined that this approach might result in temporal and spatial gaps in bait coverage, potentially leaving some rodents without exposure to baits. Additionally, to ensure accessibility to bait for all mice, including pregnant or nursing females, the spacing between bait stations was reduced to a 10-meter grid. Consequently, the plan was revised to exclusively utilise bait stations across the entire Settlement area. Generally, the LHI community preferred the use of bait-stations as they were familiar with their use in rodent control over many years. Although some leaseholders did approve of hand broadcast on their properties, this operational change was likely to be received more favourably with most island residents. However, this change to the plan had implications for the duration of the ground operation, and significantly increased the staffing requirements and the number of bait stations – from the proposed 5,000 (Saunders & Brown, 2001) to closer to 20,000.

During the same 2018 visit, grave doubts were expressed about the state of operational preparedness and that there was a significant risk that the REP was highly unlikely to proceed in winter 2018 as planned. This risk was principally due to the large number of outstanding properties without property access agreements, with the consequent very high risk that bait would not be available to all rodents, which virtually guaranteed operational failure. An additional risk arose from the Board election due in early February which had created another delay to operational planning in that there was uncertainty on the future of the project until the new Board had met in mid-March 2018. By then it would have been too late to order the toxic bait or 19,000 bait stations, to arrange the necessary specialist and baiting staff, and confirm the helicopter operator required in time to complete the eradication in winter 2018. To allow the necessary time to secure the remaining Property Management Plans, enable time for more planning, staff recruitment, procurement and training, a delay until 2019 was suggested and actioned.

Although in the two years leading up to this time multiple delays to consents and permits had stalled progress with the project, there were also several other milestones that had not been reached over the previous two years, such as the Property Management Plans, Captive Management pens, and senior staff recruitment. This meant that a significant amount of preparatory work had not been done, such as operational planning, procurement, support staff recruitment, and logistical planning. Despite the long lead-up time to the project since its inception in 2001, there was insufficient time between the final decision to proceed in 2017 and the proposed implementation in 2018, and indeed the actual implementation in 2019. In another project, much more preparatory work may need to be carried out before the decision to proceed is determined.

Furthermore, there was also an apparent lack of understanding of what was required from government entities involved with the project such as the Department of Sustainability, Environment, Water, Population and Communities, and the NSW Office of Environment & Heritage. This translated to a lack of visible support and leadership for the project. In addition, the LHIB Senior Management Team needed to have a good working understanding of the requirements for the eradication project and the basic principles that underpin a successful operation and how it would impact the day-to-day operations of the LHIB (See Section 2.5: Impacts on Business as Usual). Full support and clear understanding at this level, and engaged program sponsors may have translated to a better culture of support for the project amongst LHIB staff and the community. In a 2024 Community Survey (Lord Howe Island Board, 2024), only 52% of people were satisfied with how the project was managed, despite 78% of respondents being supportive of the concept of eradicating rodents from LHI.

There are many other examples where project management and planning could have been improved over the course of the lead-up to and implementation of the LHI REP, but as with any project attempting something on a scale previously untested, there will always be aspects that are unforeseen or unknown. There was a significant amount of hard work to make the project a success and all the staff should be applauded for that. The ecological recovery of LHI is a testament to the dedication of all staff, contractors and volunteers involved, as well as the passion of the LHI community.

Lessons Learned:

- Clearly defined governance and reporting structures from the outset provide transparency and accountability.
- Senior managers, community leaders, and government representatives must fully understand the project's principles and community needs, ensuring comprehensive support.
- Identify and engage influential community leaders early, maintaining regular communication to build trust and gain community-wide support.
- Project managers should cultivate strong relationships with government and community leaders to facilitate consents, provide high-level support, and project a united front.
- Governance bodies should include representatives with expertise in ecological, social, and financial aspects, and have clear oversight of project milestones and budget.
- Individuals on the governance body must have specific responsibilities regarding achieving project milestones, and budget supervision. They must have the ability to directly advise the project lead of any possible problems that are occurring.
- Early access to legal and planning support can streamline consent processes and address potential challenges.
- Non-project staff must be fully briefed on the project's requirements and how their roles contribute to its success.

2.4 Staffing

Desired Outcome:

The operation has adequate, suitably experienced, and continuous staffing, plus contingencies, that employs locals, has a comprehensive resourcing and training plan, a streamlined contracting process, and a robust team governance and structure.

Actual Outcome:

The LHI REP employed a significant amount of the local population, but staffing and recruitment were key issues in the program, with a short recruitment timeframe, lack of some areas of expertise, and inadequate staff redundancy.

The LHI REP was an enormous undertaking, requiring a large number of experts, project staff and field staff. Major recruitment exercises were undertaken during the program – bringing in highly experienced international and Australian eradication practitioners, large numbers of contract staff and local community members.

The LHI REP employed >20% of the local working-age population (63 people), making up 45% of the project workforce. This meant that most households on the island were represented by at least one team member. This provided a critical conduit for the dissemination of trusted information to the community, and project champions, which increased local participation in conservation and future custodianship of project outcomes.

Volunteers were also an asset to the program, raising morale and sharing knowledge with the local team. REP Volunteers assisted in bait distribution, monitoring bait uptake and rodent activity and maintaining bait stations. Additionally, in 2018 and 2019, an ecotourism campaign engaged conservation volunteers to undertake baseline monitoring.

There were several staffing issues that arose. The LHI REP was probably the most complex eradication project undertaken, and aspects of the staffing resources were underestimated, unforeseen or underutilised.

Critical staff were contracted far too late in the planning and development process, with the key positions of the Ground Operations Manager and Assistant Project Manager Operations. This was in part due to the delay and lack of certainty in the APVMA permitting process meaning that contracts could not be confirmed until the permit was granted, which didn't happen until August 2018. Contract uncertainty also puts contractors in a difficult position which often results in them

having other commitments which they need to complete before beginning the new contract. In hindsight, several key roles could have been present on the island well-before (and some positions well-after) the operational stage of the project (Table 2).

Staffing shortages and the lack of redundancy contributed to overwork, exacerbating fatigue and emotional stress. The intense pressure of managing intricate logistics in a remote location added to the strain, particularly for those isolated from their usual support networks. The emotional toll was significant, as staff faced the responsibility of a high-stakes project alongside public scrutiny and, at times, resistance. This was especially challenging for island residents who had to navigate both personal and professional conflicts. Some team members even experienced hostility from those opposed to the project, further intensifying stress.

These challenges underscore the need for better mental health support, earlier recruitment, and robust planning in future projects. Addressing these factors is essential for staff well-being and the long-term success of large-scale conservation efforts

Lessons Learned:

- There were considerable benefits to employing local staff, including project ownership and trusted communication channels.
- Recruitment was a time-consuming exercise. Engage a contractor to recruit and train staff or outsource resourcing the project entirely.
- There needs to be a clear organisational chart that clearly states roles, responsibilities and titles. This may need to evolve as project's progress and change.
- Build in redundancies to each role.
- Staff continuity is important, especially in management roles. Plan to have experts on-site early and leave late.
- The community liaison needs to be well-resourced, with a trusted local person acting as a Community Liaison Officer, working alongside a Project Manager (Community) and consider engaging a dedicated technical law expert.
- Engage Volunteers early. They provide a morale boost, increase work quality/rate, and help to reduce costs, while providing desirable experience to people in the industry.
- Build a core team of excellent communicators to give better core understandings of community values and attitudes and make working with the community more productive.
- Prioritising mental health and wellness through proactive monitoring and support ensures the well-being of all team members, creating a healthier and more resilient workforce.
- Provide mental health resources for staff working on the project.
- Clearly defined roles and targeted recruitment ensure the team has the necessary expertise and accountability.
- Managing workloads and building redundancy is crucial for maintaining performance and preventing burnout.

2.5 Impacts on Business as Usual

Desired Outcome:

The project is successfully run alongside business-as-usual (BAU) and key business functions continue uninterrupted during the operation.

Actual Outcome:

The REP caused significant disruption to BAU for the LHIB and administrative teams were under resourced.

The project significantly impacted the internal resources of the LHIB, despite initially being intended to be managed separately, running alongside the day-to-day functions of the Board.

Although parts of the project were run by contractors, there was a significant amount of administrative burden on the LHIB including: payroll tasks, recruitment, purchasing complexities, managing a multitude of contracts and making travel and visa arrangements. The project was highly reactive, with frequent changes and an extension that added to the workload.

The administrative team struggled with prioritising tasks for the REP, and many BAU tasks were sidelined, including the Weed Eradication Program (WEP), policy reviews and statutory requirements. Years later, the impact of these delays is still felt. In 2024, only 18% of respondents to a community survey believed there was little or no BAU impact of the REP (Lord Howe Island Board, 2024). Administrative tasks during the REP snowballed, with inadequate support for tasks like Freedom of Information (FOI) requests, adding to workload and stress, and straining internal relationships. The addition of a biosecurity team was rushed, creating further administrative workload without proper planning or funding.

Better integration with the NPWS improved the situation during the RRP, but earlier involvement during the REP could have better leveraged their resources for compliance and legal expertise.

Lessons Learned:

- It is easy to underestimate the impact of such a complex project on BAU activities.
- Consider externally contracting the entire project so BAU can continue.
- Additional administrative support should be brought on as part of the project. Do not underestimate the resourcing required to manage this workforce.
- Leverage larger organisations and project partners resources where possible.

2.6 Data Management and GIS

Desired Outcome:

An accurate, efficient, and user-friendly means for mapping and monitoring of field devices is in place, and has been trialed, well before the operation begins.

Actual Outcome:

Field devices were accurately placed on respective grids, enabling complete bait coverage. Data capture devices were available for all field staff to record the establishment and servicing of bait stations.

In 2018, a Geographic Information System (GIS) was developed to ensure high-accuracy placement of bait stations (every 10m ±2m). An IT technician, with significant input from the Ground Operations Manager and GIS/software providers, created an electronic data capture infrastructure. The system had three main requirements: (1) High-accuracy GPS: ~1-2m underneath canopy cover; (2) Mobile application: user-friendly, off-line data capture, synced back at the base; and (3) Mobile device: user-friendly, waterproof, rugged, good battery life.

The final selected system incorporated a base station set on Malabar Hill, a mobile repeater unit, Trimble R10 GPS as the high accuracy GPS for the set-up phase and AGM A8 rugged phones as mobile data collection devices. Data capture involved the use of a barcode scanner in the mobile device to identify barcoded bait stations alongside a data collection application. As LHI does not have a mobile phone network, records were stored on the mobile device and downloaded once returned to the base each evening.

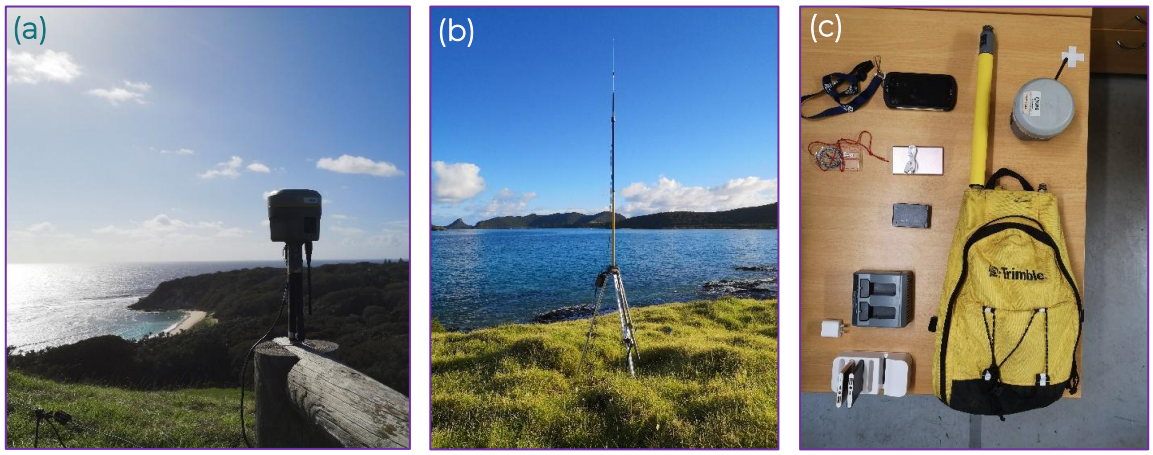


Figure 7: GIS equipment; (a) Base station set on Malabar Hill; (b) Repeater unit at the southern end of the island; (c) Rover unit and backpack for field staff - including phone and supporting tools. Source: Dion Fabbro.

With this combination of GIS equipment and maintaining line of sight between the base station and repeater this system provided ~30cm accuracy and 95% coverage of the ground baiting network was achieved. There were some minor difficulties in some coastal cliff areas where there was no appropriate position for the repeater.

The mobile application Fulcrum was found suitable in all trials and used successfully throughout the operation. Besides the application developed for data capture of the initial bait station placement and bait deployment and checking, addition applications were developed in-house extended to include roof space baiting, rodent detection device deployment and recording, rodent sighting response, and for bait station recovery at the end of the operation. The application could be readily modified to adjust for changes in desired information capture. For example, for the search phase the application was readily amended, so that if there was rodent sign the data included the type of sign. In later stages of baiting, data included if faeces were brown, green, or mixed (as an indication of if the rodent had already consumed bait).

Lessons Learned:

- The challenges faced on Lord Howe Island (lack of cell phone coverage, terrain difficulties) are not unique to this location and will need to be thoroughly investigated and systems tested well in-advance of the program beginning.
- Good communication of the requirements for the ground operation between the Ground Operations Manager and GIS technician(s) with eradication experience was essential during the trial and development stages some 12 months before the field operation commenced, and during the operation.
- Good support from the software and hardware providers was essential to have a robust, user-friendly system in place.
- Accurate and timely mapping (i.e. overnight turnaround) was essential for the Ground Operations Manager and Community team to know how each baiting round was progressing and respond to any shortfalls in bait coverage.
- Contract experienced GIS technicians with experience in eradication or large pest control projects, as they will be better suited to understanding and providing a service tailored to the requirements of the operation.
- Undertake trials of the proposed GIS and data capture systems at least 12-18 months prior to commencement.
- Ensure the data capture system is user-friendly, intuitive, and able to be modified to encompass changes to data requirements at different stages of the operation.

2.7 Procurement

Desired Outcome:

A well-resourced, well-staged, clear, and user-friendly procurement program is in place well before the field operation begins. Sufficient storage space is available to receive, record and store purchases.

Actual Outcome:

The scale of the range of goods and storage required was underestimated, as was the administrative burden to run the process.

Procurement for the REP was a significant challenge, particularly leading up to the operational stage, and this had not been fully anticipated in the planning documents. This resulted in the procurement processes being under-resourced, with few experienced staff, making the process difficult to manage effectively in the early stages. The scale of the procurement task was enormous, with several team members working part-time, leading to gaps in coordination for specific items and resulting in delays.

The logistical complexity of getting supplies to a remote island with limited transport options, added further challenges. Transporting goods required precise timing to align with the island's shipping schedule, which was infrequent and subject to weather conditions. This made it difficult to ensure timely delivery of essential items. Additionally, the project required a wide variety of items beyond the usual eradication operations matrix, given the need to manage human infrastructure and waste requirements. Navigating the complex procurement system, unfamiliar to most of the staff, led to further delays, compounded by limited financial delegation to the Project Manager and Assistant Managers.

A lack of sufficient storage space for stockpiling and managing inventory added another layer of difficulty. The strain of undertaking such a large procurement exercise within the Lord Howe Island Board, combined with limited storage facilities, put considerable pressure on both REP and LHIB staff.

Lessons Learned:

- Procurement activities need to be well-resourced.
- In remote island settings, logistics are significantly more complicated. Planning should consider limited transport schedules, potential weather disruptions, and the need to build extra lead time into procurement and shipping processes. Having contingency plans in place for delayed or missing items is essential.
- The procurement process and clarity of budget delegation needs to be well-established before proceeding with recruiting staff.
- Sufficient secure storage needs to be available early in the eradication planning stages.
- Procurement at the stores level needs a dedicated staff member to receive, record and store supplies, and be charge of disbursement of supplies.

2.8 Accommodation

Desired Outcome:

Ample suitable accommodation is available to house all external staff for the duration of the operation.

Actual Outcome:

Accommodation was always constrained during the operation and was often expensive.

Rental and short -term accommodation supply is extremely limited on Lord Howe Island, so local accommodation providers (hotels, lodges) were primarily used for external contractors and volunteers.

External accommodation was expensive, and often wasn't available continuously (particularly as the program extended into tourism season), so staff were often shifting between accommodation blocks during the operation, which was unsettling and added additional strain. Earlier planning incorporating accommodation availability with staff presence on the island may have reduced this problem. Additional expenses were also incurred when accommodation had to be cancelled due to project delays and there was no provision for refunds – such was the case when accommodation was booked in 2017 for the planned 2018 eradication which was postponed until 2019.

More awareness of the staffing and accommodation resources may have helped alleviate some of these issues – but accommodation will likely always be an issue in any remote island where the workforce increases significantly for a large project.

Lessons Learned:

- Create an accommodation strategy if working in a remote area.
- Secure long-term accommodation for staff well before the operation starts, with a flexible refund policy in case of delay.
- Consider building additional accommodation that can be used in future projects or setting up temporary accommodation for the duration of the project.
- If commercial accommodation is required, book refundable or transferrable options to allow for unforeseen delays.

3 Technical Implementation

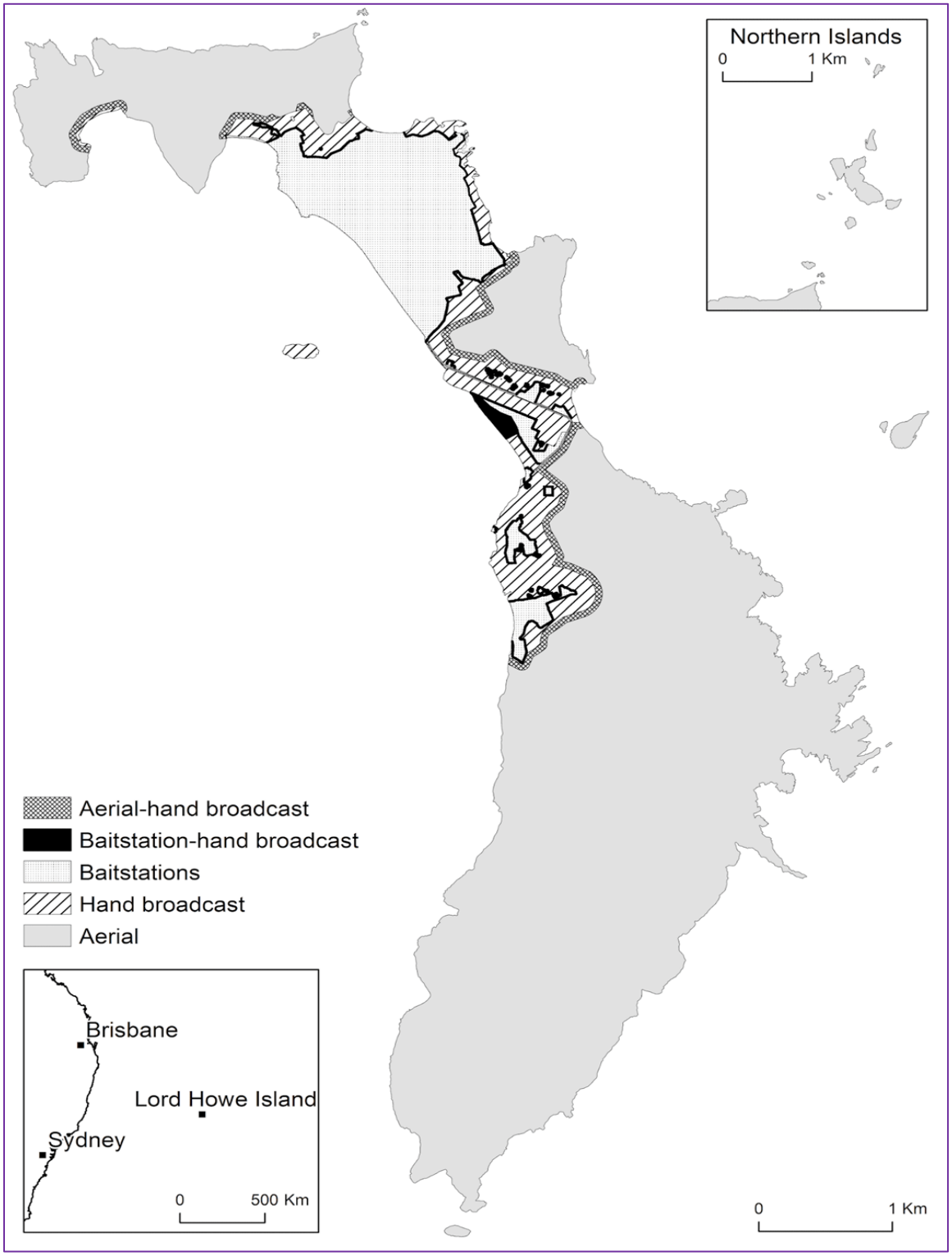


Figure 8: Spatial technical implementation of the LHI REP.

3.1 Hand Broadcast

Desired Outcome:

Hand-broadcast is used in areas where it is safe to do so, and it is required to ensure complete bait coverage.

Actual Outcome:

Hand-broadcast was used to overlap between areas of aerial bait application and bait stations, and in areas where highly accurate bait application was required.

Initially, hand broadcast of baits was to be used widely across the Settlement, but many within the community would not accept hand broadcast on their land particularly where there were children and pet dogs, preferring bait stations only. A Human Health Risk Assessment (Toxikos, 2010) found that the amount of bait needed to be ingested to be fatal, even to a small child, is very large (200 pellets in an acute single dose). However, concerns remained from people in the community, particularly parents, about bait ingestion and these should not be dismissed.

Hand broadcast was used to overlap between areas of aerial application and bait stations (Figure 8 & Figure 9) – at an application rate of 12kg/ha in the first application, and 8kg/ha in the second across 9,500 hand broadcast points. It was carried out simultaneously with the two aerial applications.

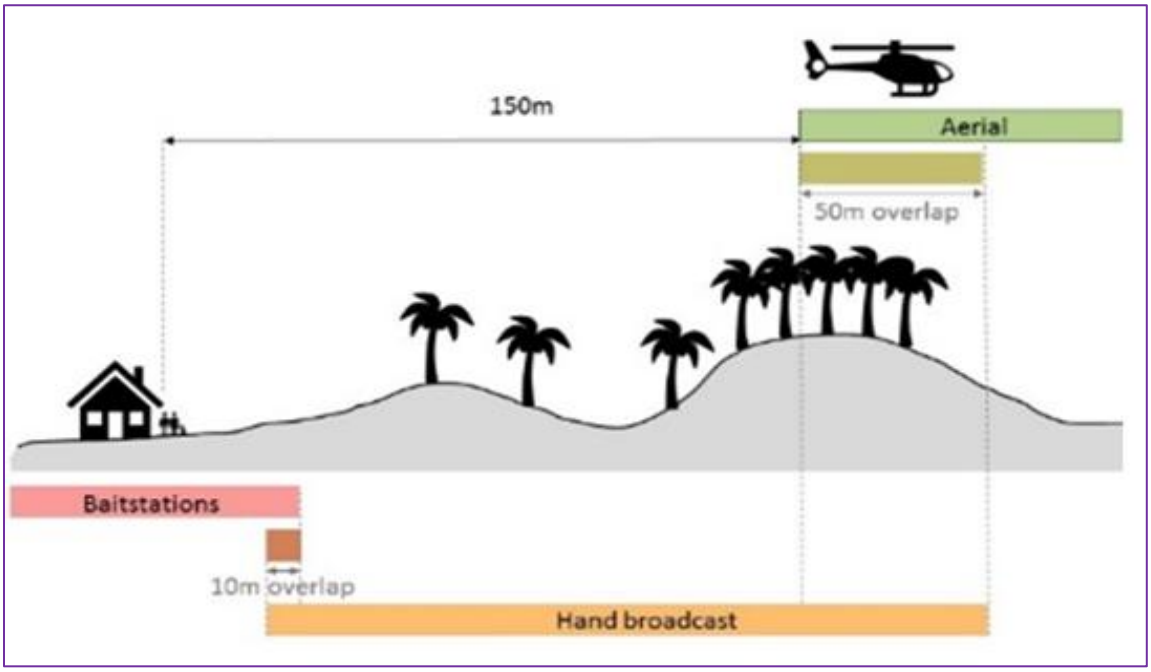


Figure 9: Hand broadcast was used to overlap between areas of aerial application and bait stations.

Later, additional hand-broadcast application was carried out in pasture near sites with vestigial clusters of rat detections, to circumvent any remaining rats dispersing into rodent-cleared forested sites. Bait was also hand-broadcast on the island's aerodrome to ensure highly accurate bait application around, but not on, the tarmac runway and timed to avoid aircraft.

Lessons Learned:

- Hand-baiting is significantly more labour-intensive than aerial baiting but is less labour-intensive than bait stations.
- Hand-baiting is useful in areas where highly accurate bait application is required.
- Do not assume that the community will accept hand broadcast as an appropriate method even if the science says it is safe. Legitimate concerns will remain, and these should not be overlooked or dismissed.

3.2 Bait Stations

Desired Outcome:

If required, an effective network of bait stations is deployed and serviced efficiently.

Actual Outcome:

A complex network of bait stations, requiring multiple minor operational changes, were used in the LHI REP.

External Bait Stations

External bait stations were the Globe™ (Globe Pest Solutions). Securing and transporting 19,000 bait stations was a formidable exercise. The bait stations had to be sent from the USA, and a prompt dispatch and transfer to the island's supply ship meant that a possible delay to project implementation was averted. To reduce water damage to bait an inverted coffee cup lid was added on the raised internal portion of the bait station as a bait tray, using hot-glue guns as no other glue would adhere to the plastic. Barcodes were stuck inside the bait station lid to ensure staff needed to open the lid to scan the barcode and therefore check the bait station status which also improved quality control. This work was led by a volunteer managing the local ground baiting team and was a critical task to expedite the ground baiting operation.

Bait stations were initially loaded with 80g of bait (40 pellets) which was progressively reduced to 10g by the 6th baiting round as rodent activity declined. Fewer bait pellets meant bait take by rodents was easier to rapidly check and reduced wastage.

Although most cattle were removed from the island during baiting, four herds remained, requiring 2600 bait station covers to allow bait station servicing while protecting them from crushing by cattle. These were triangular covers to deter cattle from standing on them, made of pre-cut 17mm plywood, shipped in, and constructed on island. Cattle covers were expensive in time and resources and would not have been required if the original proposal of removal, and eventual replacement, of stock had occurred. This is another example of how a clear understanding of social complexities and what was possible from a community standpoint would have assisted with operational planning.

Internal Bait Stations

The internal bait stations were the Protecta Evo™ (Bell Labs) – a total of 4,300 of these stations were established across the settlement area. Internal bait stations were loaded with 12g of bait pellets for the duration of the operation, and check frequency declined after two months as rodent activity reduced.

Bait stations were closed inside dwellings for safety reasons, whereas bait stations were left open and placed around the roof access hatch in roof spaces to provide a more secure bait dispenser and simplify bait loss counts. Restrictions were placed on bait placement in roof spaces by health and safety requirements and liability associated with possible electrocution or falling through a ceiling. The need for roof baiting needed to be identified and planned for well before the ground operation was implemented.

Following a review of existing access points and roof types, individual lease holders and residents were contacted regarding obtaining permission to bait relevant roof spaces. An independent contractor was contracted to be on-island for a few weeks in September/October 2019 and in this time 230 roof spaces were accessed and baited (93% of identified un-baited roof spaces).

Lessons Learned:

- Components of the ground operation not previously encountered in rodent eradication operations on uninhabited islands contributed to significantly more operational complexity. These included the need to bait all the residents' properties, inside their buildings and roof spaces, along with public amenities such as the school and playing fields.
- Where possible reduce or eliminate the area or need to ground bait. Ground baiting, particularly the use of bait stations, significantly increases the cost and complexity of an eradication operation.
- Bait stations take a significant amount of time and staffing to establish and service, but the cost of not having community support is likely greater.
- Strive to remove or isolate all stock/chickens from the island for the duration of the operation and immediately after, to reduce the areas requiring bait stations.
- Minor jobs, like sticking barcodes to bait stations, are often overlooked in the project planning stages, but need to be factored into the scheduling to ensure the operation proceeds on time.
- Bait stations were an effective method for eradication of mice, but not for complete eradication of rats. Bait station avoidance by a small percentage of rats was evident in the latter stages of the REP ground operation.

3.3 Aerial Baiting

Desired Outcome:

Where it is logistically possible and safe to do so, aerial baiting is used in a rodent eradication.

Actual Outcome:

Aerial baiting was used successfully across most of LHI during the REP.

Aerial application of baits was the only feasible method to safely and effectively distribute the bait on areas such as the southern mountains and northern hills of LHI. Despite this, aerial baiting is generally not appropriate in populated or residential areas – and it was the method that caused the greatest concern in the LHI Community (Lord Howe Island Board, 2024).

Aerial application of bait is a well-established method of bait dispersal for eradications (Broome, Golding, Brown, Corson, & Bell, 2014) because it gives every rodent on the island an opportunity to find and eat enough bait within a short period of time. Due to the small size of some mouse territories, ground-baiting in the Permanent Park Preserve would have required putting bait stations at close intervals over the whole island, including the cliff faces of Mt Gower and Mt Lidgbird, which was simply not feasible.

For the LHI REP, two helicopters completed two rounds of aerial baiting in June and July – spreading a total of 47 tonnes of bait over 2600 ha (1300 ha per round – representing nearly 85% of the island's terrestrial area - Figure 8). Total flying hours during the operation was 76 hours for the baiting and associated tasks (calibration, boundary familiarisation, reconnaissance).

Lessons Learned:

- Aerial application is the only feasible method to distribute the bait safely and effectively across mountains and thick forest while ensuring that every rodent has an opportunity to find and consume enough bait in a short period of time.
- Aerial baiting is generally not appropriate in populated or residential areas.
- Inclement weather will add to standby time costs – ensure extra redundancy is in place in the budget for this.

3.4 Tasking of Staff and Servicing of Field Devices

Desired Outcome:

Servicing of field devices is undertaken efficiently and effectively across all land tenures.

Actual Outcome:

Property access and social complexities underpinned issues with tasking of staff and servicing of field devices.

The LHI REP, even once underway, retained a level of opposition in the local community due to inconsistent messaging around the project, and ongoing concerns over bait toxicity. This opposition, coupled with local politics, resulted in an exceedingly complex tasking process for staff servicing field devices.

The Assistant Program Manager (Community) was responsible for all community engagement, PMP's and briefing the team supervisors on access to property. The tasking of baiting teams was extremely complex – with some leaseholders only allowing particular people onto their properties at particular times. Trying to balance these social requirements with the technical need to service devices in a timely manner was increasingly intricate. A Community Planning Team (CPT) was ultimately formed, comprised of staff with community liaison experience or detailed knowledge of local politics and relationships.

The CPT tasked appropriate teams for each separate leased plot and their access requirements, ensured each team had appropriate workloads, and tied it in with the overall baiting plan. Leases were given an ID code and loosely grouped so teams could work through a block of neighbouring leases each day. The CPT needed to call each leaseholder and gain prior access permission for the planned access day and negotiate timing and team members allowed access. These conversations were being repeated every 8-12 days with each baiting round and became increasingly refined. Initially many phone calls were often difficult or tense or were avoided by leaseholders.

The CPT approach was to engage in conversations with empathy and honesty. This resulted in solid relationships forming with most of the community and less difficulty securing access. Over the course of the baiting rounds many leaseholders became more relaxed about access requirements as they became familiar with teams and the work. Local staff were essential as team members and there were a few invaluable 'super accessors' within teams who were able to access almost all properties.

Lessons Learned:

- Social complexities can easily impact operational implementation.
- Local staff and their personal relationships are crucial to project success.
- Involve a Community Planning Team (CPT) early in the process to avoid overpromising and ensure commitments can be met.
- Involving the CPT in rostering ensures the right people are available for property access. Additionally, managing the pack-down schedule through the CPT maintains consistency and efficiency.
- Leveraging local knowledge and coordinating daily actions are essential for ensuring ground operations goals and actions are centralised and tracked.
- Effective data management, including GIS support and mapping, is crucial for accurate planning and decision-making.

3.5 Waste Management

Desired Outcome:

A Waste Management Plan is in place to reduce waste or alternative food sources for rodents, as well as removing carcasses during the operation.

Actual Outcome:

A significant amount of alternative food and shelter for rodents was removed from the island in a successful campaign with leaseholders, and a large number of rodent carcasses were collected from the settlement area.

In May-August 2016, the LHIB offered free removal of hard waste for residents and businesses across the island. The reduction in accumulated hard waste on leases was expected to reduce rodent habitat, as well as improving the island's aesthetic value, improving visitor experience and being beneficial to human health and safety. This project was a great success – with many residents and businesses registering interest, and over 400 tons of hard waste removed from the island – reducing some of the potential shelter sites for rodents before the REP was underway.

Figure 10: An example of hard waste collected from leases during the 2016 Island Cleanup

During the operation, alternative food sources for rodents had to be managed so rodent bait uptake was maximised. The production of organic waste such as compost was a major alternative rodent food source and was considered a significant risk during the planning stage. Organic waste was present in orchards and gardens as compost, vegetables and fallen fruit, at the island's Waste Management Facility (WMF), and from the few restaurants and grocery stores. The WMF was a significant risk site and REP staff assisted to clean up the site and reduce refuges and food sources for rodents. The Waste Management Coordinator also worked with the REP project team by improving the waste management processes, particularly with the 'Hot-Rot' industrial composting machine.

A waste management plan was in place and working well before the baiting stage of the operation, which allowed the locals to adjust to the new regime. Dissemination of interpretive material to the community provided context and rationale for the new waste management procedures. Implementation was assisted by the employment of a local resident with practical skills and good community links as the Waste Management Manager. A waste management team provided lidded plastic pails for all householders and commercial operations and collected waste on a regular basis for disposal at the WMF. The 'Hot-Rot' at the WMF processed the organic matter into compost within 24hrs, which was then removed from the island.

All orchards/gardens were checked for fallen or rodent-chewed fruit by baiting teams during baiting rounds. Fallen fruit was collected and returned to the owner or sent to the WMF for composting. Where possible orchard and garden owners were encouraged to collect their own fruit and vegetables daily, and any waste became part of the REP waste collection scheme. Some fruit and vegetables were particularly sought after by rodents (particularly avocados, sweet citrus, passionfruit, banana) and where these were grown were often rat 'hot-spots'. Most leaseholders cooperated with collecting fallen fruit and the removal of compostable waste using the lidded buckets collected by the Waste Management team. A significant amount of alternative food for rodents was removed by this method. In addition to this effort a large amount of compostable waste was still recovered by baiting teams during each baiting round and transferred to the WMF for composting. This was a highly successful part of the REP, both from a community and operational perspective.

Monitoring of non-target deaths and possible secondary poisoning required the baiting teams to collect poisoned carcasses during their baiting rounds. Rodents and non-target species carcasses were collected from within the Settlement and most carcasses were dissected and assessed for cause of death. Rat demographics and breeding data assisted the last few months of baiting strategy and prioritising monitoring/dog checks. Samples were also collected from rodents for a DNA record. Carcasses were then disposed of in the WMF 'Hot-Rot' composting system.

Lessons Learned:

- Reduce shelter sites for rodents well before the field operation.
- Reduce waste or food sources for rodents as early and as much as possible. This is alternative food to the rodent bait and does not include natural food (e.g. insects/molluscs and seeds/fruit of native plants). This includes compost, stock/chicken food, vegetable gardens, fruit on trees/ground. Dispose of this waste so rodents do not have access to it.
- Develop and implement a waste management plan well before the operation, so the community have plenty of time to adjust.

4 Environment

4.1 Human Health

Desired Outcome:

Impacts of the operation on human health are eliminated.

Actual Outcome:

Human health impacts of the LHI REP were identified as minimal early in the process and were successfully managed during the operation.

An Environmental Health Risk Assessment is the process of predicting the potential impact of a chemical, physical, microbiological or psychological hazard on a specified human population or ecological system under a specific set of conditions (Environmental Health Standing Committee, 2012). Toxikos Toxicology Consultants, on behalf of the LHIB, completed such a risk assessment in 2010 for the use of brodifacoum in an attempted eradication.

Overall, although brodifacoum is an acutely toxic substance that has the potential to cause toxicity and even death through internal bleeding, the human health risk to Lord Howe Island residents during the proposed eradication campaign was assessed as very low. Even via direct ingestion by a child, the likelihood of health effects occurring is negligible. Locals did use brodifacoum regularly for rodent control, so there was already a significant history of anticoagulant use well before the REP was proposed. The authors concluded that the eradication project, if successful, would result in a lower ongoing risk of toxic exposure than continuing rodent control (Toxikos, 2010). At the request of the Minister for the Environment, the NSW Chief Scientist and Engineer commissioned an independent Human Health Risk Assessment for the Rodent Eradication Project (NSW Chief Scientist and Engineer, 2017), following on from the 2010 Toxikos report after a number of concerns continued to be expressed about potential human health impacts of the eradication and after the 2015 community survey.

The report recommended that the proposed Rodent Eradication Project was not expected to result in adverse health effects for any individual due to exposure to brodifacoum (NSW Chief Scientist and Engineer, 2017). Noting that a number of the community concerns were outside the scope of this risk assessment (e.g. issues around health and wellbeing, likelihood of success), the report also recommended that the Board deliver a communication strategy, a monitoring strategy and reports on community and environmental outcomes.

Subsequently, no adult, child, or pet were reported to have ingested bait, or showed any signs of anticoagulant poisoning, during or after the LHI REP. In a 2024 Community Survey administered

as part of this report, 69% of people felt that the risk of bait exposure was adequately managed for themselves, and their families, and they felt safe throughout the project (Lord Howe Island Board, 2024).

Table 4: Exposure pathways for potential anticoagulant poisoning (Toxkios, 2010)

Exposure Pathway	Risk Comments
Direct ingestion of bait	The amount of bait needed to be ingested to be fatal, even by a small child, is very large (200 x 2g pellets in a single acute dose)
Inhalation of dust containing brodifacoum	It is theoretically possible that Island residents could be exposed to bait dust in the air during aerial broadcast operations. A reasonable maximum estimate of the amount of brodifacoum that might be inhaled during this time is five million times less than the dose that doesn't affect the body.
Ingestion of soil contaminated by brodifacoum from bait	Highly unlikely to occur as accidental ingestion of soil is very low, as is the level of brodifacoum in the soil.
Dermal exposure to bait and contaminated soil	Brodifacoum is very poorly adsorbed across the skin. Absorption through the skin poses a negligible risk.
Ingestion of ground or tank water that may become contaminated by bait	Contamination of tank water may occur if aerial broadcast of bait accidentally spreads pellets onto roofs, or birds consuming baits and leaving droppings on a roof. With contingencies in place, these events are unlikely to place significant amounts of brodifacoum onto the roof, certainly not enough to affect the body.
Consumption of foods that may be contaminated by brodifacoum (e.g. vegetables and fruit, poultry, fish, meat/dairy, goat, duck)	Poultry, cattle and goats are to be removed from the island or isolated from bait consumption during the eradication. Consumption of wild ducks is not said to occur on the island. Contamination of fish and seafood is a plausible pathway, but it is concluded that there is a negligible risk from this pathway, including from infants and children. Brodifacoum does not leach from soil or contaminate vegetables. It is not transported from soil or water into plants.

Lessons Learned:

- An Environmental Health Risk Assessment will likely be required by an eradication operation taking place within or near a human settlement.
- Do not assume that a scientific study will put all people at ease. People have genuine concerns and these need to be listened to, not dismissed. It is one thing to have the toxicity level documented in a scientific study, it is another thing to be comfortable with your child potentially consuming toxic bait on a remote island.

4.2 Non-target Species

Desired Outcome:

Non-target species impacts are managed to an acceptable level.

Actual Outcome:

Non-target impacts of the LHI REP were identified early in the process and any likely significant impacts were successfully managed during the project.

Non-target species impacts are a reality of any conservation program, particularly an eradication. It is important to plan for losses. It is rare that non-target impacts will be reduced to a zero level during an eradication. Instead, an acceptable level of non-target impacts should be established at a population level. It is important to consider the big-picture as the non-target impacts during the operation will be greatly outweighed by the benefits of an eradication. Knowledge of the pre-eradication non-target populations and undertaking Population Viability Analyses will provide detail on whether the losses can be accepted.

Risks to non-target species, mainly through primary or secondary poisoning from ingestion of bait, were identified in the early stages of planning the LHI REP (Saunders & Brown, 2001; Parkes, Ruscoe, Fisher, & Thomas, 2004). Non-toxic bait trials, conducted on the island in 2006 and 2008 (Lord Howe Island Board, 2007; Lord Howe Island Board, 2008), established that Lord Howe currawongs (*Strepera graculina crissalis*) and Lord Howe woodhen (*Hypotaenidia sylvestris*) were particularly vulnerable to anticoagulant bait. Invertebrates were observed interacting with baits, although were not at risk due to their different blood physiology (Shirer, 1992; Morgan, Wright, Ogilvie, Pierce, & P, 1996).

This determination of susceptibility to the chosen bait, coupled with the species' threatened status, necessitated planning for captive management of the species during the eradication operation. To mitigate these risks, approximately 90% of the woodhen population and 50% of the currawong population were taken into captive management during the eradication (O'Dwyer T. , Carlile, O'Neill, Fairlamb, & Bower, 2023).

Both species have successfully survived and bred in captivity in the past (Miller & Mulette, 1985; Barrett, 1926), and a captive management workshop was held at Taronga Zoo in 2012 to ascertain the avian captive management techniques to be employed during the rodent eradication program. This workshop included one representative from the LHI community, who provided valuable local knowledge for the planning. The LHIB and Taronga Zoo undertook an additional captive management trial for both the woodhen and currawong on LHI in 2013 that not only tested husbandry aspects but also logistical, infrastructure and staffing considerations (Taronga

Conservation Society Australia, 2014). This trial demonstrated that both species could be effectively held in captivity during the high-risk period of the project, and successfully released at its conclusion.

After the successful trial, a Service Agreement was established between the Lord Howe Island Board and Taronga Conservation Society Australia for captive management of woodhen and currawong associated with the LHI REP. This partnership with a captive management organisation engages a broad skillset – not just specific species knowledge but also the skills of qualified veterinarians, pathologists, nutritionists, animal keepers and tradespeople, as well as experts in logistics and human resources. This comprehensive approach to the program can not be underestimated and outsourcing the captive management component of the project significantly reduced stress on the project management team and experts in other fields to concentrate on their areas of expertise without distraction.

There was a significant effort to bring pre-built flat-packed aviaries to the island and building them on site, with many delays. There were minor repairs to the captive management facility needed in March 2019 and Taronga Zoo accepted handover of the facility in April 2019. The facility consisted of:

- 70 Currawong aviaries.
- 10 Woodhen pens and 6 smaller isolation pens.
- A demountable office building serving as the bird food prep kitchen and staff office space, connected to power, water and internet and includes waste-water storage tank.
- A 10” shipping container that served as a vet hospital facility.

Currawongs needed to be housed in pairs rather than a large flight aviary so that conspecific aggression, food intake and general animal behaviour could be more easily monitored. The 2013 food trials (Taronga Conservation Society Australia, 2014) showed that some currawongs did not adjust as effectively as others to a captive diet, and it would have been impossible to monitor this food intake in a larger group. Monitoring of negative social behaviour or isolation of a single bird due to ill-health would have also been more challenging in a large aviary where the birds can use the entire 3-dimensional space. In contrast, woodhens only travelling on the ground could be more easily monitored and were housed in communal pens. Currawong cages were fitted with perches and a base layer of 50 mm of sand. Wooden pens were fitted with a base layer of 100 mm of mulch and various habitat features (such a palm fronds).

The capture of both the Woodhen and Currawong commenced in mid-April 2019, a partnership between Taronga Zoo, Office of Environment and Heritage (OEH) and the LHIB team. This significant operation involved hand-netting of woodhens and net spring trapping of currawongs across the island. Birds in the settlement and low-lying areas were taken to the Taronga team at a captive management facility. Inaccessible areas including the summits of Mount Lidgbird and Mount Gower, were reached by staff who were flown by helicopter to capture birds. The birds were then flown directly to the airport using a specially designed crate that was slung under the helicopter – holding about 50 individually packaged woodhens inside. No woodhens or currawongs were injured during transport into or out of the facility.

Processing into the captive management facility included: banding, a physical health assessment, and DNA sampling. Blood samples were taken from a subset of birds to establish baseline data on population health. Data on all birds coming into the facility and daily individual reports were recorded in ZIMS (Zoological Information Management System). Birds were housed in numbered aviaries or pens with experienced Taronga keepers undertaking the day-to-day care of individuals in the facility. Both species generally settled well into captive-management and day to day husbandry and management routines became well-established.

During the captive period, four Currawongs had been euthanised due to animal welfare concerns regarding aspergillosis. Taronga Zoo implemented a preventative anti-fungal treatment regime for other birds. Three woodhens died in captivity during the captive period. One died from a non-infectious respiratory disease. One was a bird that was brought in after the initial capture and was observed eating bait in the wild. Despite being given Vitamin K the bird did not survive. One bird sustained an injury to one of its toes and was separated into a smaller pen containing two other birds for treatment since woodhens tend not to eat well when housed individually. These birds were aggressive towards it, so it was moved to another enclosure with only one other bird and given extra cover, but it was attacked overnight and died the following morning despite treatment. Whilst these deaths in captivity are unfortunate, it should be remembered that a normal wild population has regular deaths. In fact, during the captive management program losses were less than the equivalent time duration outside in previous years due to natural attrition, age-related illness and road-related trauma.

The capture and husbandry of these species was a considerable logistical exercise. To put this into perspective: each fortnight the birds (129 currawongs and 220 woodhens) consumed approximately 85 kgs of fresh food, 16 dozen eggs and 6 kg of meal worms. 10 cubic metres of mulch was replaced fortnightly. The Taronga team consisted of around 30 staff who stayed on-island on a rotational basis, including one full-time supervisor and one full-time vet nurse, as well as 2-3 other bird keepers. However, the costs involved with this program are far outweighed by the benefits seen to both species after rodents have been eradicated. Alternative methods of managing these non-target impacts may have resulted in technical failure of the eradication. Woodhens and Currawongs were released in stages well after the end of the baiting program to ensure no toxic baits were left in their habitat. Monitoring of the birds included radio-tracking and blood tests to ensure they survived their release.

Woodhens and currawongs were not the only species considered during the planning process, but after a risk assessment and a cost-benefit analysis it was determined that other species were at low risk of harm or were a high additional cost to keep in captivity compared to the risk of harm from the program. Surveillance of Masked Booby and Providence Petrel colonies before and during aerial baiting operations showed no disturbance from the helicopter activities. For other terrestrial non-target species, monitoring walks commenced after the start of aerial baiting. Low numbers of non-target species carcasses were collected their numbers were all well below thresholds for mitigation established in regulatory approvals. It is important to note that the overall objective of the REP was to permanently reduce impacts to more than 70 species on LHI, so

these low-level impacts on a small number of other species were justified by the overall project benefits. The LHI Community were generally happy with how impacts on non-target native species were managed during the REP (Figure 11).

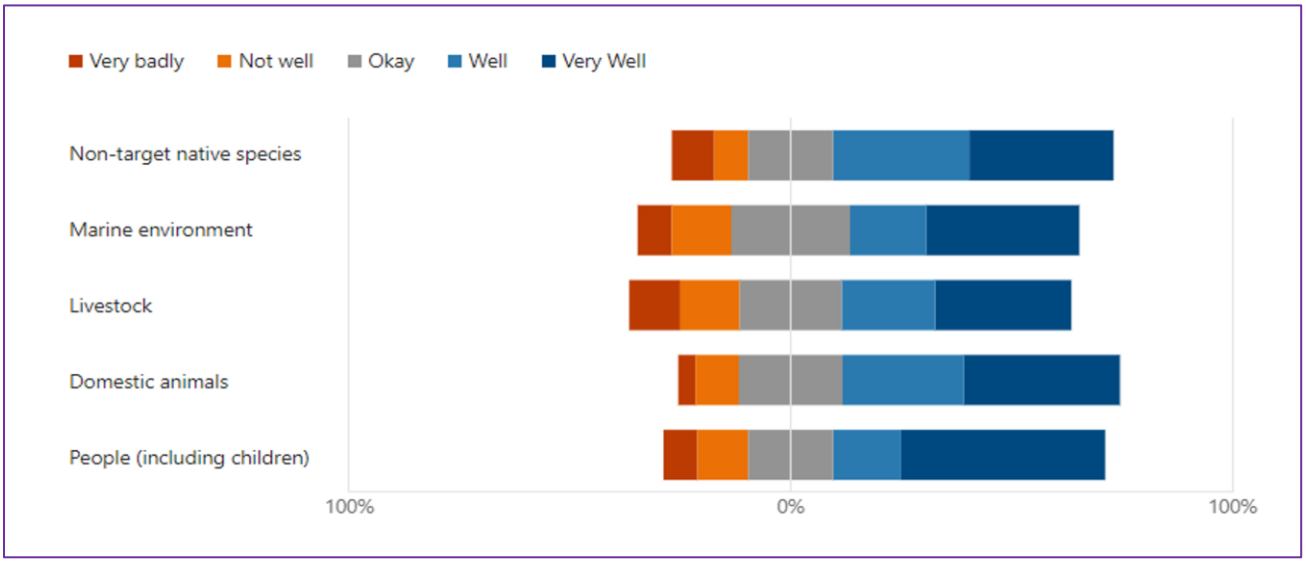


Figure 11: Results of a voluntary LHI Community Survey (2024) on how well people thought various impacts were managed during the REP.

In addition to the REP was the concurrent eradication of the introduced Masked Owl (Milledge, Bower, & Carlile, 2019), which was depredating many local seabird species and a threat to the Island's biodiversity. The owls would scavenge rodent carcasses and fall victim to secondary poisoning. There were several benefits pof running the two operations at the same time.

Lessons Learned:

- An acceptable level of non-target impacts should be established at a population level. The non-target impacts during the operation will be greatly outweighed by the benefits of eradicating a key threat.
- Captive management of particularly susceptible threatened species may be more appropriate in the long-term, and more palatable to the public, than accepting losses.
- Undertake comprehensive bait deployment trials using non-toxic bait early in the planning process to identify possible bait uptake by non-target species.
- If deemed appropriate, plan for captive management of non-target native species at high risk from the operation early in the planning process and have the infrastructure and management agency in place well before the operational phase of the eradication begins.
- Partnerships with captive-management institutions will be critical. Skills and experience in this area are a necessity before attempting captive-management of threatened species.

4.3 Marine

Desired Outcome:

There are no significant marine impacts from the eradication, and the local community that consume marine species are confident in the results of monitoring.

Actual Outcome:

The LHI REP showed no significant impacts on seawater and freshwater. Residual brodifacoum was detected in a small number of fish species for some time, but is no longer at a detectable level.

For successful eradication, all terrestrial habitats which may harbour rodents must receive bait, including smaller islands, ocean cliffs and islets. When brodifacoum pellets are applied aerially to these areas in attempts to eradicate rodents a small quantity of bait will likely enter the near shore marine environment. All marine impacts by the LHI REP were deemed minimal with appropriate controls in place. A key control was that no bait pellets baits were to be intentionally applied to the marine environment.

Inadvertent application of bait into the lagoon was minimised by hand baiting along the lagoon foreshore; only baiting above the high-water mark; and the use of a deflector on the spreader bucket when aerially applying bait on the coast. Bait application into waters adjacent to small islands, ocean cliffs and islets was minimised using a highly accurate trickle-baiting bucket.

Department of Primary Industries (Fisheries) permit and Marine Parks permit stipulated monitoring of water and fish sampling for brodifacoum levels as part of the LHI REP. Monitoring of coastal seawater (in areas adjacent to creek mouths) and fresh water (creeks, bores, rainwater tanks) two weeks and four months after the aerial bait applications found no detectable levels of Brodifacoum in any sample.

Fish samples (liver and flesh) were collected after the first and second aerial applications from several kingfish, trevally, bluefish, garfish and mullet from near the shore. After the first application, a small number of samples (mostly livers) were found to contain very low traces of brodifacoum. Two flesh samples out of 20 (one mullet and one bluefish flesh sample) were found to contain very low residue levels, just above the limit of detection and well below the Human Health Risk Assessment (HHRA) guideline criteria. It should be noted that a rigorous sampling procedure was not in place before the REP, and historic brodifacoum baiting on the Island may have contributed to these levels. Routine post-REP fish sampling currently indicates no detectable brodifacoum residue in fish flesh. Small numbers of fish liver samples continue to return brodifacoum residue on the lowest end of detectability. While within the acceptable level for

brodifacoum for seafood, as described in the LHI Human Health Risk Assessment Report developed by the NSW Chief Scientist, advice was in place to avoid consuming the liver of fish caught near the shore of LHI. This advice was revoked in June 2024 when annual fish sampling found no detectable levels of brodifacoum residue in flesh or liver, concluding the need for fish testing.

A robust monitoring program of marine impacts will need to be implemented for any similar project. While there was a number of sampling points for the LHI REP, the monitoring program could have been improved. Shortfalls in the program, including a failure to undertake sufficient baseline monitoring, and implement rigorous sampling procedures, make it difficult to understand the true impact of the REP on the marine environment.

Another potential impact of an eradication on the marine environment is the increased supply of nutrients from bird guano as seabird populations increase. Too many, or too few, nutrients can change the abundance and species of corals and algae on a reef, which can have flow-on effects for fish and invertebrates. A collaborative research and monitoring program has been established by LHI Marine Parks to identify and monitor the different sources of nutrients in marine water around the island and their ecological effects – a similar research program should be investigated where there is potential for marine impacts. Good baseline data on seabird populations before the eradication will help inform these studies.

Lessons Learned:

- Monitoring of environmental impacts on the marine environment will be required, from both a compliance and social perspective.
- A robust monitoring program for the marine environment needs to be implemented and followed.
- Do not assume that residents will be confident in the results of monitoring. Remember that these are people's lives and livelihoods.

4.4 Livestock

Desired Outcome:

The impacts of the eradication on livestock are eliminated, and livestock numbers are either nil or as small as possible during the implementation stage.

Actual Outcome:

Most cattle and chickens were dispatched from the island for the operation, and adjustments were made to accommodate the remaining animals.

The Human Health Risk Assessment (Toxikos, 2010) recommended that all poultry, cattle and goats be removed from the island, or isolated from bait consumption, for the entire operation.

Sales of milk from dairy cattle were stopped during the baiting and all milk produced was destroyed daily. The dairy cattle owner received compensation for the duration of the ground operation. Approximately 70 cattle were dispatched over the 12 months prior to implementation of the program, freeing up significant areas of land for hand or aerial broadcast. Owners were compensated for replacement value of the cattle. An estimated 24 cattle and 2 horses remained as compensation agreements were unable to be reached with owners. Baiting around those livestock was undertaken using bait stations with wooden trample proof covers installed.

Approximately 200 chickens were dispatched prior to implementation. It was estimated that approximately 20 chickens remained. These were penned during the program in either a purpose-built chicken pen on Board land as a last-minute concession or in a few circumstances, remaining at owners properties with either pen upgrades and/or treadle feeders installed.

Three domestic goats were removed from the island permanently. With these domestic goats removed for the REP, there are now no goats left on the island, following an eradication campaign of feral goats in 1999 (Parkes, Macdonald, & Leaman, 2002).

Milk and egg samples were collected five days after bait stations were first loaded in the dairy herd area and from two locations where laying hens are being kept. No detectable levels of brodifacoum were found in any sample, and it appears they were always safe for consumption, however the precautionary advice regarding consuming milk and eggs remained in place throughout 2019. Additional sampling immediately after the bait stations were removed confirmed that these items were safe for consumption.

The management of livestock throughout the project was an enormous undertaking which antagonised some members of the community. Some would not allow their cattle to be removed

from the island due to personal values, mistrust of the LHIB, or as active opposition to the project. Specific livestock management plans on each property were therefore put in place as part of the PMP's which identified extra resource and staff time needed. For the cattle that remained, their paddocks had bait stations established with plywood covers pegged over the top to stop trampling – requiring some 2600 covers to be assembled on-island; another operational change that required a large amount of time and resources. These stations were checked by staff members every day to ensure they were in place. Each herd was kept in as small a paddock as possible with enough grazing and space, so hand broadcast could then be used in the non-grazed paddocks. Other options, such as establishing a temporary feedlot rather than producing bait covers, were not technically feasible with the requirements of the eradication program.

The LHIB fulfilled its obligation to restock cattle after the conclusion of the REP with a number of cattle being transported to the Island in June 2022 after a lengthy and complex livestock importation process involving biosecurity clearances, quarantine periods, custom-built transport crates, a one-off barge journey and extensive veterinary checks and oversight.

Lessons Learned:

- Develop a livestock strategy early in the planning phase of the project and engage affected stock owners regarding preferred and alternative strategies.
- Develop contingency plans in case of changes to plans.
- Strive to remove all stock/chickens from the island for the duration of the operation and immediately afterwards.
- Have a designated 'Livestock Officer' or Officers, with experience in managing stock, as part of a community engagement team, depending on project size.
- Do not underestimate the work involved in livestock management.
- If livestock are to be returned to the location post-eradication, plan for this well in-advance and be prepared for a potentially complex operation.

4.5 Domestic Animals

Desired Outcome:

The impacts of the eradication on domestic animals are reduced to zero.

Actual Outcome:

The impacts on domestic dogs were successfully managed during the LHI REP.

As well as wild animals and stock, an eradication may pose a threat to domestic pet animals. Feral cats were eradicated as part of the LHI Woodhen recovery program in 1979, and as of 1982 domestic cats are not permitted on the island (Department of Environment and Climate Change (NSW), 2007). Domestic dogs are allowed on LHI, under specific circumstances outlined in the LHI Dog Importation and Management Policy (Lord Howe Island Board, 2019).

Initially, dogs were proposed to be kenneled off-island for the duration of the operation or always wear a muzzle when outside. This plan was not acceptable to the dog owners. Being parted from a companion pet for six months and being concerned for its welfare or change in behaviour whilst kennelled was unacceptable to 80% of dog owners, and having their dog muzzled was either not acceptable or not feasible for 50% of dog owners (Pearson, 2020).

Instead, baiting methodology was modified so there was no hand broadcast in the main settlement area and foreshore areas, where dogs may have picked up pellets. Other areas on the island where hand broadcast was carried out had signage (and information of when this was due to happen) so dog owners could make decisions on whether to walk their dog at these locations or use muzzles. Muzzles were offered to each owner but not all owners wanted to use them. Health and safety information material was also disseminated, and a training session was offered for every dog owner explaining the likely symptoms and effect that ingesting a pellet would have for a dog and the mitigations that were in place. The risk to a dog (according to dog size) from ingestion of one or several pellets was explained as well as the process of administering the antidote Vitamin K through the local doctor and veterinary nurse. In addition, the comparison between the ongoing rodent control (a large amount of baiting distributed using bait stations had been carried out on LHI since the 1980s) and the planned eradication was highlighted.

Lessons Learned:

- People will have concerns about their pets ingesting bait pellets. The use of bait stations should address this concern – but they should be pegged down, or placed out of reach, to stop dogs disturbing them and accessing pellets.
- Every dog should be measured for a muzzle with the dog owners receiving it in advance to try out. This provides time for swaps in muzzle sizes and styles. Each dog owner could revise their decisions as to whether to use the muzzle or not ahead of baiting.

5 Biosecurity

5.1 Biosecurity Planning

Desired Outcome:

Biosecurity is part of the eradication planning process, and the community is involved in the development of a biosecurity plan. Before proceeding with an eradication, residents, government agencies, and companies servicing the island should be fully aware of the biosecurity requirements to maintain pest-free status and have a biosecurity program in place.

Actual Outcome:

A degree of biosecurity infrastructure and processes was in place before the operation began, but limited funding and support for improvements in biosecurity process or infrastructure meant there was several iterations of a biosecurity plan before the conclusion of the eradication operation.

Biosecurity is an integral part of a pest eradication project, and without it, the risk of re-invasion by the target pest species threatens its success. The primary risk pathways for pest transport to LHI are the fortnightly sea-freight voyages and daily air-freight and passenger flights from the mainland (Table 5).

Table 5: Potential risk pathways for the introduction of pest species to LHI. NB; this assessment does not incorporate consequence rating, it only refers to likelihood of physical transport only (Pahor, 2020).

Pathway	Risk of introduction
MV Island Trader - sea freight and operations	Very High
Flights - regular passenger transport	Moderate
Flights - freight	Moderate
Flights - other	Moderate
Private Yachts/ small vessels	Moderate
Shipwrecks	Low
Storm enhanced dispersal and rafting	Low
Deliberate release by public	Low

Despite a history of considering biosecurity risks for LHI (Landos, 2003; AECOM, 2016), none of the primary transport pathways to LHI had adequate dedicated, rodent-specific biosecurity facilities in place prior to the REP. Pre-border quarantine measures (at airports, ship/freight yards,

hangars, etc.) ranged from non-existent to low at the conclusion of the REP (See Theme 6). This issue was highlighted by the detection of rodents on the supply ship in the lead-up to the eradication operation.

At the start of the LHI REP planning, LHIB senior management may not have fully appreciated the critical importance of high-standard biosecurity to ensure a lasting successful outcome for the project or been able to secure adequate funding. Although the original eradication plan prepared by NPWS included biosecurity costs for LHI within the $9.5M budget, subsequent funding for biosecurity planning and implementation was separate from the project budget and had to be sourced from other bodies. Consequently, the implementation of the required biosecurity infrastructure and staffing was deferred early in the planning process.

Although rodent detection dogs and handlers were trained by the end of 2017 and a Biosecurity Plan was submitted to the EPBC as part of the approval process in August 2018, very little of the plan was actioned in time to have effective protocols, a trained team, and a suitable suite of surveillance and response tools in place, which meant it was not fully developed by the completion of the REP. Although some infrastructure and protocols were in place, the biosecurity procedures and processes for the main pathways to LHI were still well below the required standard in 2019.

By the finalisation of the REP in December 2019, the LHIB faced uncertainty and unpreparedness regarding biosecurity. A biosecurity plan had not been finalised, the team structure was not formalised, essential processes were yet to be created, and key stakeholder engagement had not taken place. Additionally, there was no operational budget allocated for the necessary level of biosecurity post-eradication. Although a few biosecurity staff positions had been created and filled, LHI biosecurity delivery was weak due to a lack of resourcing, support, and funding. This was exacerbated by the few existing Biosecurity staff being redirected to the eradication program – biosecurity needs to be running as business-as-usual while the eradication occurs in parallel.

Most importantly, the local community had not been taken on the biosecurity ‘journey’ to understand what was required after the completion of the REP and the need for their support to ensure that biosecurity became part of their everyday processes when ordering supplies, employing off-island contractors (e.g., builders), and traveling to and from the island. Garnering community buy-in for the enhanced biosecurity required during and after an eradication is an integral part of eradication planning in the initial stages of implementation.

Further to this, limited strategic planning and change management had taken place, leading to severe team burnout. To address some of these issues, a shared Team Leader position was created, combining a local project manager and an eradication/biosecurity consultant. This role was responsible for leading the team of dog handlers and the rapid integration of biosecurity plans, processes, and stakeholder engagement to establish foundational rodent biosecurity and advocate for an appropriate budget.

The importance of change management in this context cannot be overstated. Effective change management may have minimised resistance, ensured a smooth transition to enhanced

biosecurity protocols, and maintained morale among staff and stakeholders. By providing a structured approach, the LHIB could have addressed potential obstacles early in the process, ensuring that the necessary resources and support were in place. Effective change management could have facilitated clear communication, helping the community and staff understand the importance of biosecurity measures and their roles in the process. This would have been crucial in overcoming financial and operational challenges, ultimately leading to a more successful and enduring outcome for the eradication project.

Lessons Learned:

- Engaging local communities from the start and fostering a culture of biosecurity through education and involvement is critical for long-term success. This requires dedicated efforts and resources to build trust and cooperation.
- Future projects must ensure that adequate funding is allocated to biosecurity from the beginning. This includes securing funds for necessary infrastructure, technology, skilled personnel and ongoing operations.
- Establishing a biosecurity team early in the project timeline is crucial. This allows ample time for planning, training, and the establishment of necessary protocols and infrastructure. This team should continue to carry out biosecurity actions separate to the project to ensure both requirements are covered.
- Effective change management strategies, including stakeholder engagement, comprehensive training programs, and consistent communication, are essential. Recognising the need for additional workforce and the effort required to integrate them smoothly into the organisation is crucial to ensure all team members understand and support biosecurity measures from the outset.

5.2 Ongoing Biosecurity Program

Desired Outcome:

Effective, community-supported biosecurity surveillance and quarantine procedures are successfully implemented and funded before the project begins and continue in perpetuity.

Actual Outcome:

Ongoing biosecurity, surveillance and quarantine procedures for LHI are now in-place and funded, as per the LHI Biosecurity Strategy 2022-2024 – but these costs were not fully identified early on.

An effective biosecurity program can significantly minimise the risk of reinvasion or invasion of foreign species, but never truly eliminate it. The LHIB commissioned a report into the effectiveness of biosecurity measures immediately after the REP (Pahor, 2020), which considered the likelihood of accidental introduction or reintroduction of rodents to be 'likely' or 'almost certain'. The Lord Howe Island Biosecurity Strategy 2022-2024 (Lord Howe Island Board, 2022) aims to reduce the likelihood of invasive species (including, but not limited to, rodents) introductions to between 'likely' and 'possible'.

Likelihood of entry, establishment, and spread	
Rating	**Description**
Almost Certain	Very high probability of occurring within the budgeted period.
	Has happened several times in the past year and in at least 4 of the 5 previous years.
	Has a 90% chance of occurring in the budgeted period if the risk is not mitigated.
Likely	High probability of occurring within the budgeted period.
	Has happened at least once in the past year and in 3 of the previous 5 years.
	Has a 60-90% chance of occurring in the budgeted period if the risk is not mitigated.
Possible	Even probability of occurring within the budgeted period.
	Has happened several times in the past 5 years but not in every year.
	Has a 40-60% chance of occurring in the budgeted period if the risk is not mitigated.
Unlikely	Low but not negligible probability of occurring within the budgeted period.
	May have occurred once in the last 5 years.
	Has a 10-30% chance of occurring in the budgeted period if the risk is not mitigated.
Rare	Very low probability of occurring within the budgeted period.
	Has not occurred in the past 5 years.
	May occur in exceptional circumstances.

Table 6: The rating system used in the Biosecurity Strategy (2022-2024) for the likelihood of entry, establishment and spread of invasive species on LHI (Pahor, 2020).

This strategy, along with a significant government funding commitment, allows the LHIB to enhance and maintain the existing biosecurity systems. The key components of the strategy are:

- Minimise the risk of non-native species being introduced to LHI.
- Early detection of any new introductions that do occur.
- Specific surveillance monitoring for high-risk groups of non-native species.
- Effective response to new introductions when detected.

To address these aims, there is a biosecurity team both on LHI and the mainland via an external contractor team stationed at pre-border at Port Macquarie, the first port of departure for Lord Howe Island for sea and air freight. Freight arriving from other mainland ports (Sydney and the Gold Coast) are subject to independent but not formally Board sanctioned biosecurity measures.

While rodents are a key focus of the biosecurity program after the REP – the biosecurity effort for rodents also captures multiple other organisms including non-native reptiles, mammals, plants, fungi and pathogens. At the time of writing, the following biosecurity measures are in place for protecting LHI from rodent incursion:

- Aircraft (private, commercial, medical and military) have been met at the LHI Airport on arrival since 2020 – with all freight and passengers subject to inspection by an authorised biosecurity officer and biosecurity detection dog.
- An authorised biosecurity officer and biosecurity detection dog team have inspected freight leaving the Eastern Air Services (freight and small commercial airline operator) Port Macquarie hanger since 2019.
- All arriving vessels are inspected by an authorised biosecurity officer and if required a biosecurity detection dog. The master of the vessel must show evidence of compliance with biosecurity requirements before they depart their last port.
- The island's cargo ship is inspected in both Port Macquarie and LHI by authorised biosecurity officers and biosecurity detection dogs. The shipping company have a biosecurity management plan in place.

At the time of writing, the LHIB and project partners are working on the Critical Infrastructure Program for Lord Howe Island, which includes significant upgrades to pre-border biosecurity and quarantine measures located on mainland Australia, and to the border and post border biosecurity measures on the island.

This program is underpinned by the biosecurity continuum; a concept that underpins successful biosecurity strategies by recognising that exposure to risk and the associated management implications are different at different locations. These factors have a bearing on the most efficient use of resources which will be accounted for in the following ways:

1. The new pre-border biosecurity facility on the mainland will align with modern biosecurity practices, serving as the island's first line of defence against invasive species and biosecurity threats. This will allow for the thorough inspection and pre-clearance of goods prior to shipping.

2. In tandem with the facility, a purpose-built ship will replace the aging marine freight vessel that services the island. This new ship will incorporate advanced biosecurity features, acting as the second line of defence. Together, the pre-border biosecurity facility and the new ship will significantly reduce the likelihood of non-native invasive pests and diseases from reaching Lord Howe Island.
3. Biosecurity measures at the border of Lord Howe will serve as the third checkpoint with inspections, quarantine and potentially physical import restrictions.
4. The current and ongoing surveillance programme (see Section 5.3 – Ongoing Biosecurity Monitoring) is the final line of defence which integrated with measures designed to respond and control any threats that make it to the island.

These biosecurity initiatives form part of the Critical Infrastructure Program, which also includes the development of a master plan incorporating the Marine Strategy, waste management solutions, and infrastructure upgrades essential for the Island.

The cost of this ongoing biosecurity requirements, including the implications for shipping and transport, were probably understated in original cost-benefit analyses and not adequately provided for as part of the REP.

Lessons Learned:

- It costs more to maintain rodent-free status than it did to achieve it.
- Even with unlimited resources, biosecurity is never infallible, an effective program can minimise risk, but never truly eliminate it. An effective biosecurity strategy can greatly minimise this risk. It's important to be prepared for an incursion with a well-considered and regularly tested incursion response plan.
- Comprehensive biosecurity infrastructure and processes need to be established well before eradication efforts begin. This ensures that there are effective measures in place to prevent re-invasion and maintain long-term biosecurity.
- The biosecurity program on LHI has so far been effective in keeping LHI rodent-free since the Rodent Response Project (RRP), with no known incursions since the conclusion of the program (See Section 6.6 – Incursion or Survivors?).

5.3 Ongoing Surveillance

Desired Outcome:

A well-designed, well-resourced surveillance program is permanently in place to provide a rapid and effective respond to emerging biosecurity threats.

Actual Outcome:

LHI now has an effective ongoing biosecurity surveillance program in place, but it is at a significant ongoing cost.

Ongoing surveillance for invasive species is a fundamental element of an eradication program. The surveillance network on LHI is crucial to maintaining the rodent-free status of the island, informing management actions if an incursion is detected, and acting as a reminder to residents and visitors of the importance of protecting the island's environment. The cost of this ongoing monitoring effort required was likely understated – which was not adequately identified in early cost-benefit analyses.

An effective surveillance system is based on strategically positioned and regularly serviced devices. Following the eradication operation, a mixed biosecurity network of approximately 340 detection and kill devices were installed across the roughly 200 ha of the Settlement and checked periodically. Detection devices included a range of peanut-lured wax tags, chew cards and tracking cards, with baited bait stations and DOC150 trapping boxes. An additional disparate network of detection devices was installed at roughly 300m intervals along all walking tracks within the Permanent Park Preserve.

Two biosecurity detection dogs were also permanently present on-island so these dogs and their handlers could periodically undertake searches of the settlement for invasive species (rodents, reptiles, and amphibians). However, immediately following the REP, this detection dog-search program did not achieve the desired surveillance coverage due to budget constraints, understaffing and injuries putting the dogs' out of action.

Following the REP/ RRP, the surveillance network was upgraded to include strategically placed wildlife cameras which capture still images constantly throughout the year. The large volume of images captured (2million +) are currently analysed by an AI based system. This surveillance system will be reviewed and receive a significant upgrade in 2025 and will include real-time AI monitoring of camera footage, remotely triggered kill traps and multi-purpose detection systems for a broad range of biosecurity threats. This ties in with the broader biosecurity initiatives of the critical infrastructure program.

There are now four fully trained biosecurity detection dogs with handlers (biosecurity officers) which service the border on the island (Jetty, visiting vessels and airport). There is also a rolling program of checks with the Lord Howe detection dogs across the whole island, which is supported by biosecurity detection dog contractors on a quarterly basis.

Based on data from the detection devices collated during the 2021 LHI Rodent Response (Theme 6), an estimate of how long it would take for an incursion to be detected on LHI was modelled by Bode (2023). The results suggest that, on average, the surveillance network would be likely to detect an incursion (i.e., with probability > 50%) within two weeks of a rat arriving on the island (Figure 12). The network has a probability > 99% of detecting a rodent within 10 weeks. Detection dogs were the best performing surveillance tool and currently a contracted team of rodent detection dog teams search the settlement area every 12-weeks, and the Settlement Crown blocks every other 12-weeks.

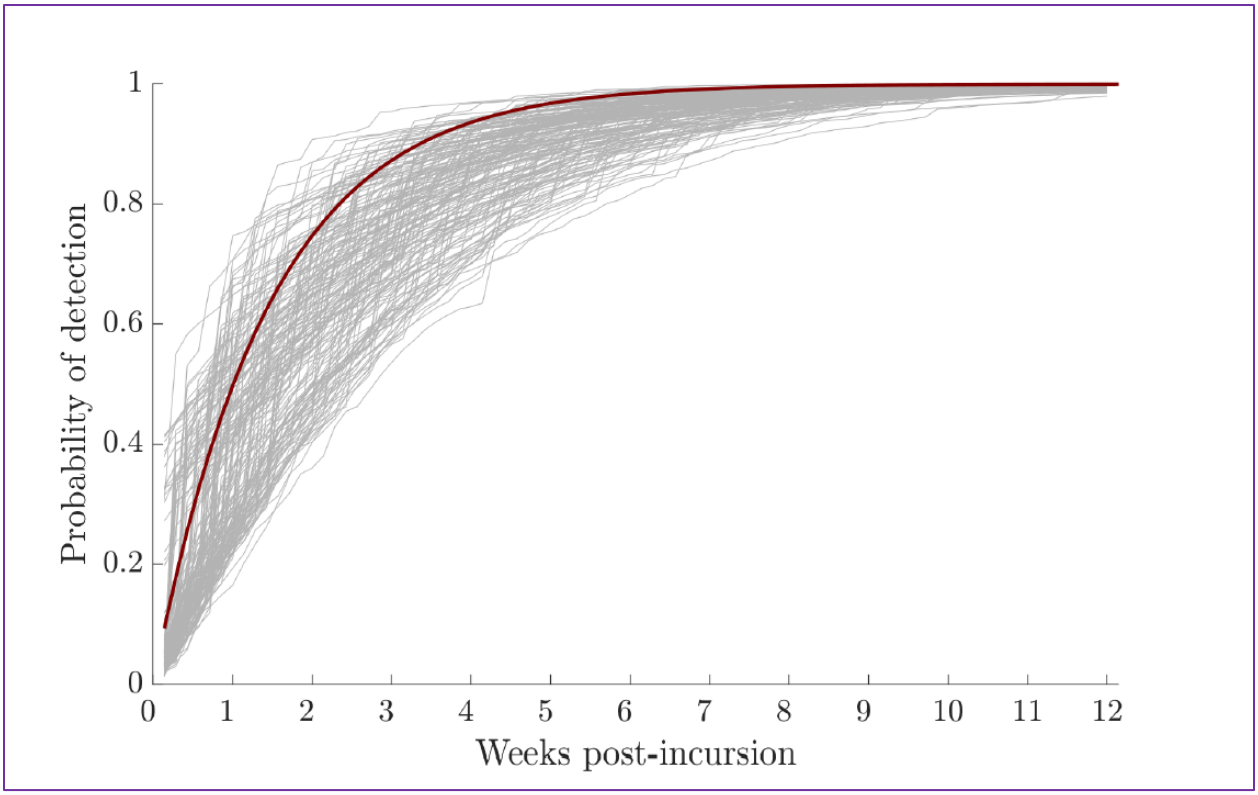


Figure 12: Mean probability, and variance, that an incursion by a single rat would be detected by the proposed surveillance network (Bode, Analysis of proposed Lord Howe Island surveillance network, 2023).

In essence, LHI had the best possible biosecurity monitoring system given the resources available at the time. However, securing funding for expansion of the program was difficult, and took over two years of continuous effort to appropriately map out biosecurity requirements. The system was improved immediately following the detections of the RRP, but issues were identified earlier.

Technical limitations and significant risks inherent in the existing system had been comprehensively assessed immediately following the REP (Pahor, 2020), however extensive planning, review and stakeholder engagement was required for this to be planned, funded, and resourced.

Following the successful conclusion of the LHI REP/RRP, the surveillance program is ongoing. With many of the above surveillance devices being present on people's properties, in addition to regular rodent detection dog searches, ongoing community support remains critical for continued surveillance and ensuring LHI remains rodent-free and other biosecurity threats are addressed.

Lessons Learned:

- An effective biosecurity surveillance program needs to be designed, developed and established during the planning phase of a project, as it will be integral to ensuring, and declaring, eradication success.
- Intensive end of project surveillance is required to guarantee project success. The standard timeframe for this is 2 years, but experience and evidence suggest that up to 5 years would be a more realistic period of time to fully guarantee success.
- Continuous and ongoing surveillance for invasive species after an eradication operation is an essential component to consider when planning the project, as early as possible.
- It needs to be clear to the community from the outset that some level of surveillance will be essential in perpetuity.
- Biosecurity surveillance on the island does not preclude the critical need to intercept pest species before they arrive on the island. Effective quarantine is much easier and cheaper as it intercepts the invasive animal before they board the boat or plane.

6 Incursion / Detection Response – 2021 Rodent Response Project (RRP)

6.1 Surveillance and Initial Detection

Desired Outcome:

An incursion or redetection after the eradication program is quickly detected due to an effective monitoring program being in place.

Actual Outcome:

A network of detection devices and biosecurity detection dogs were present on island post-REP, but did not detect rodents at extremely low densities.

The active baiting phase of the LHI REP was undertaken from May to November 2019. No mice have been detected since June 2019, and no positive rat sign was found between October 2019 and April 2021. During this time, the assumption was that all the rodents were removed, so the detection network focused on incursion pathways (near the jetty and airport) rather than extensively monitoring the whole Island for enough time to conclude success more confidently. In preparation for potential incursions, an Emergency Use Permit of rodenticide was approved by the APVMA in August 2019 (Permit Number: PER86903).

On the 14th of April 2021, the LHIB biosecurity team received a report from a resident of a potential rat sighting in the northern settlement area. A formal investigation commenced immediately, confirming that rodent(s) were present on LHI. An adult pregnant female rat, and juvenile male, were found and destroyed within the first 24 hours. LHIB staff implemented pre-planned rodent response actions, including:

- The establishment of monitoring devices (bait stations, covered snap traps, chew cards, wax tags) on a 60 x 60m grid within a 540m radius from the rat detection site in the Initial Response Zone (IRZ).
- The existing surveillance network was checked.
- Biosecurity detection dogs began searches within and on the IRZ boundary.
- An External Technical Advisory Group (TAG) was activated.
- External rodent eradication experts familiar with the island were bought in to assist.

Between the 16th-29th April, five additional rats were detected south of the initial discovery. On 29th April another female was found in an arboreal nest almost 500m from the initial discovery. The individual and seven young were removed. Over the next nine days, 12 rats were further retrieved from an additional five den sites – up to almost 800m from the original site. In response,

the IRZ was expanded and eventually encompassed the entire northern settlement area of 190 ha.

Concurrent with this deployment was the urgent need for significant numbers of staff, bait and the associated permits, emergency funding and support from outside agencies such as the NPWS. All these requirements were ramped up rapidly following the initial appraisal of the size of the incipient rat population. Alongside this work was the restrictions posed by the ongoing changing travel restrictions posed by the global COVID-19 pandemic.

Lessons Learned:

- Whether an incursion or residual population, be ready with a well-practiced and well-resourced response program.
- Rats present at a very low population density along with locations with abundant natural food will largely avoid rodent detection devices, existing removal devices and toxic bait. Monitoring tools such as dog teams and cameras will be essential to the detection of rodents and need to be monitored regularly to maintain effective vigilance.
- Project success should not be assumed until it is proven. Moving the focus to incursion pathways at the expense of whole of landscape monitoring may result in failure to detect residual individuals.
- Detection dogs were crucial to detecting the remaining rodents, but no single detection method is infallible. Even for low detection ability, all methods have the potential to detect an individual that another method does not. Always use a combination of detection methods as all have their merits.
- If a residual population remains from an eradication operation, it is highly likely the surviving individuals will develop an avoidance of existing monitoring devices. Be prepared, with resources and permits, to trial novel methods during a response.

6.2 Response Removal Techniques

Desired Outcome:

In the event of a rediscovery after an eradication, removal techniques are well-understood, well-practiced, and adaptable.

Actual Outcome:

Within six weeks of the rediscovery of rodents on LHI, the response team had developed an effective regime for rat removal.

The response team developed an effective regime for rodent removal after they were rediscovered on LHI. Ideally an effective regime would be well-practiced and ready to go before a rediscovery, but what will work in a response situation (with likely avoidance of conventional methods used during the eradication) may be hard to predict and needs to remain adaptable. The regime developed was a 'Search and Destroy' protocol, which involved:

1. Detection of a rat(s) or den by rodent detection dogs, the field camera array, or by detection devices, resulted in the same response. Any dog team then immediately vacated the site so that any disturbance to the site was minimised as much as possible to avoid rats vacating the area. The Operations Manager and Technical Advisor then managed the subsequent response.
2. Careful establishment of 4-8 field cameras, preferably with views across the likely den entrance or runways/refuges for rats.
3. Over the next 3-5 days use of the resulting images to confirm the location, age, sex and approximate number of animals present. If no activity was observed initially, then camera monitoring continued for 10 days to confirm no rats were present. Cameras were removed after this period.
4. Using the information obtained from camera images, rat bait and lured traps were presented in the surrounding area immediately adjacent to the den at observed sites of activity and runways.
5. Monitoring rat activity by checking the previous night's images each morning and replacing any lure or baits each following evening.
6. Once rat activity had ceased, rodent detection dogs are deployed into the area to find and remove any rat bodies.
7. A rat den was monitored with cameras for a further 2-3 weeks to ensure no additional rats were missed. If no further activity was detected, the record for the site was closed off.

At the height of the rat removal process, from early May to late June, about 6-8 rat locations or dens were being monitored or dealt with on any one day. By late July the number of active dens had been reduced to two, despite the continued high intensity searching by several dog teams. The last freshly dead rat was finally removed on 2 August. At this stage 96 rats had been accounted for, and no further rats were found despite the search effort continuing until November.

It appears that some poisoned rats may have died where they could not be found or detected by dogs. In some den sites a mother and several young were noted on camera, but only the adult female and two juveniles were later found. Similarly, an adult male in the northern Settlement was recorded taking poison bait on several nights, but their body was never located. Therefore, the final tally of 96 individuals is certainly an under-estimation of the final body count by approximately 5-15 individuals.

In addition to the Search and Destroy protocol a few rats found by dog teams during the day were removed shortly after detection using a Cordon and Capture protocol. Cordon and capture (C&C) involved erecting a temporary fence around a suspected den site and was only used where it was at ground level, and the den site could be; a). encircled by the C&C netting; and b). the dens site could be taken apart easily. Once the likely den site was quietly encircled with netting all overhanging vegetation was removed and tree guards attached to any tree trunks to stop rats climbing trees. The material over the den site was then carefully deconstructed and removed from within the cordon. When a rat bolted, they were captured within the fence and destroyed. Invariably C&C were carried out in palm thatch piles as few other den sites matched the requirements for using this technique. This meant that although this removal technique was very effective it was not commonly used and only utilised five times to retrieve eight rats.

Despite not being widely used, the C&C method is a good example of using a combination of removal techniques to give the best chance at successfully eradicating the population – in the initial project planning there needs to be flexibility in permitting and resources to allow for the use of novel methods (e.g. thermal imaging that was found to be extremely valuable in learning behaviour, location and numbers) during a response scenario. This also applies for the mop-up phase of an eradication. When searching for a small number of remaining individuals, it is necessary to use all the available tools to have the best chance at success – in case individuals show avoidance towards one particular method (e.g. bait or trap type).

Lessons Learned:

- Removal techniques during a rediscovery will almost certainly differ to those used during an eradication due to rats being in very low population density with very abundant natural food being available, and development of trap avoidance in a residual population.
- As with surveillance, a combination of removal techniques should be used for an incursion. No single method is infallible, and a combination will give the best chance of removing every individual.

6.3 Response Resourcing

Desired Outcome:

Resources are immediately made available for an incursion / residual population response, and held in easily accessible storage for future responses, as per a regularly reviewed Incursion Response Plan.

Actual Outcome:

The 2021 Rodent Response was well-resourced, with support from NPWS and the LHI community.

The considerable detection and baiting grid implemented by the 2021 RRP required a significant increase in personnel to maintain, as well as associated logistics and data management. Any response needs to be a high-intensity and rapid program. The longer it takes to respond and get the required resources together, the more time the rodent population has to increase, and the situation deteriorates. Table 7 provides a picture of the resources that may be required. The previous use of local staff for the REP was a significant advantage for the rapid deployment of experienced baiting staff across the Island.

Table 7: A snapshot of the resources required for maintaining the detection and baiting grid during the 2021 RRP.

Device	Number	Location	Check Frequency
Bait Station	1,200	Settlement	1-3 days
		PPP	1-4 days when NPWS staff or Volunteers were available or ~10 days when they were not.
Chew Card	700	Settlement	1-3 days
		PPP	1-4 days when NPWS staff or Volunteers were available or ~10 days when they were not.
Wax Tag	700	Settlement	1-3 days
		PPP	1-4 days when NPWS staff or Volunteers were available or ~10 days when they were not.
Camera Trap	250	Settlement	1-2 days
Kill Trap	170	Settlement	Daily
Tracking Tunnel	67	Settlement	1-3 days
Detection Dogs	3-4 dogs (not included in total)	Settlement	Full settlement check every 21 days, alongside targeted searching. 3831km of search distance covered between April and October.
		PPP	
Total	**3,087**		

The table above is the effort of devices only, it doesn't include the significant detection-dog response. To boost this response additional dog teams were brought in to assist the on-island rodent dog teams. The rodent dog teams conducted repeated sweeps across the Settlement through all properties and supplemental sweeps were made into the PPP in the adjacent Malabar Hill and Transit Hill. These sweeps rapidly confirmed rats were only present in the northern Settlement.

In addition to detection-dog sweeps the extra NPWS staff rotated through the program progressed the installation of three detection buffers 280-400m into the PPP adjacent to the Settlement. These buffers comprised detection devices and kill traps established on a 40 x 40m grid. This buffer provided additional surveillance and opportunities to kill any rats that may have moved out of the established Response area, which was critical while the Response team was determining the extent of the rat population.

This integration of NPWS staff into the RRP was a significant help to the response, but it initially faced several challenges, including unclear roles and responsibilities, the perception of NPWS being an imposition rather than help, duplication of roles between NPWS and LHIB and an unclear reporting structure, but the introduction of the NPWS Emergency Management System helped to address this. It is recommended that LHIB conduct pre-incident planning (outside of an emergency response scenario when there is limited time) to identify necessary external support and establish frameworks for integrating outside help. This should include pre-determined agreements with agencies detailing costs, structures, and expertise required for different incidents. There is also a need for adequately trained and experienced Incident Controllers on the island, independent of the CEO, with training provided by a relevant organisation. Finally, post-incident reviews should be conducted to identify lessons and improvements, ensuring a more efficient and structured response in future operations.

Lessons Learned:

- Like the planned REP, timely procurement and effective stores management, logistic support and ongoing compliance is essential to maintain the field team and regulatory requirements.
- An Incursion Plan and all equipment and permits need to be in place, and at least annual refresher training and tests need to be conducted.
- GIS support provided the data that informed the Rodent Response strategy. The operation would have been extremely difficult to manage without it.
- Assistance from well-resourced external agencies is a huge asset to a response, but a clear framework and integration structure should be developed outside of a response scenario.
- Having trained and experienced field staff expedited the response and truncated a likely re-establishment of rats on Lord Howe Island. Continued training and incursion response exercises will be essential to maintain an effective biosecurity program for the island.

6.4 Rodent Behaviour in a Response Scenario

Desired Outcome:

Behavioural changes in rodents are predicted, where possible, and the program has an adaptive management approach with permitting early in the planning process allowing flexibility in a response scenario.

Actual Outcome:

Unexpected rodent behaviour was observed during the 2021 RRP, and the team successfully adapted the control program in response.

One of the key learnings from the Rodent Response was that rats behave differently when at very low density and in an environment with largely unlimited natural food, which was very different to the conditions that prevail during an eradication. There may also be a behavioural element of active trap avoidance if they are survivors. Incursion events or a rediscovery will likely to be approached differently to eradication/control operations, and some of the key problems encountered during the LHI rodent response are outlined below.

Detectability

The detectability of rats during the response varied between different tools, and no one method was infallible (Figure 13). The most reliable detection method was rodent-detection dogs which were essential to the Response but weren't completely foolproof. This was shown by the example of multiple dog checks not confirming a rat detection on a wax tag. Based on observations from the REP, it was assumed that dogs are roughly 75-85% effective and this was confirmed during the Response. Dogs and field cameras used in tandem were highly effective for rat detection.

Of note was the very low interaction rate of rats with passive detection and removal devices. For example, for over 39,583 wax-tag checks, there were only five recorded rat chews. Even if we halve the number of checks to consider that the last rat was dead by the end of July, and there were three more months of monitoring for no result, then this translates to an interaction rate of 0.0003. Similarly, for chew cards the interaction was 0.0001, and was zero for 3,117 tracking tunnels checks.

Kill traps were checked 8,694 times, and again, if the number is halved, it means that kill-traps only caught a rat once every 543 trap-nights, or an interaction rate of 0.001, which includes traps set at known rat dens. Camera footage revealed a high level of trap avoidance, with rats seen to ignore lured snap-traps, or if attracted to the trap, were seen to sniff, or lean towards the trap, but then avoid it. On three occasions recorded on camera, carefully set snap-traps under covers were set off by a rat with no resulting capture, which likely led to trap-shyness.

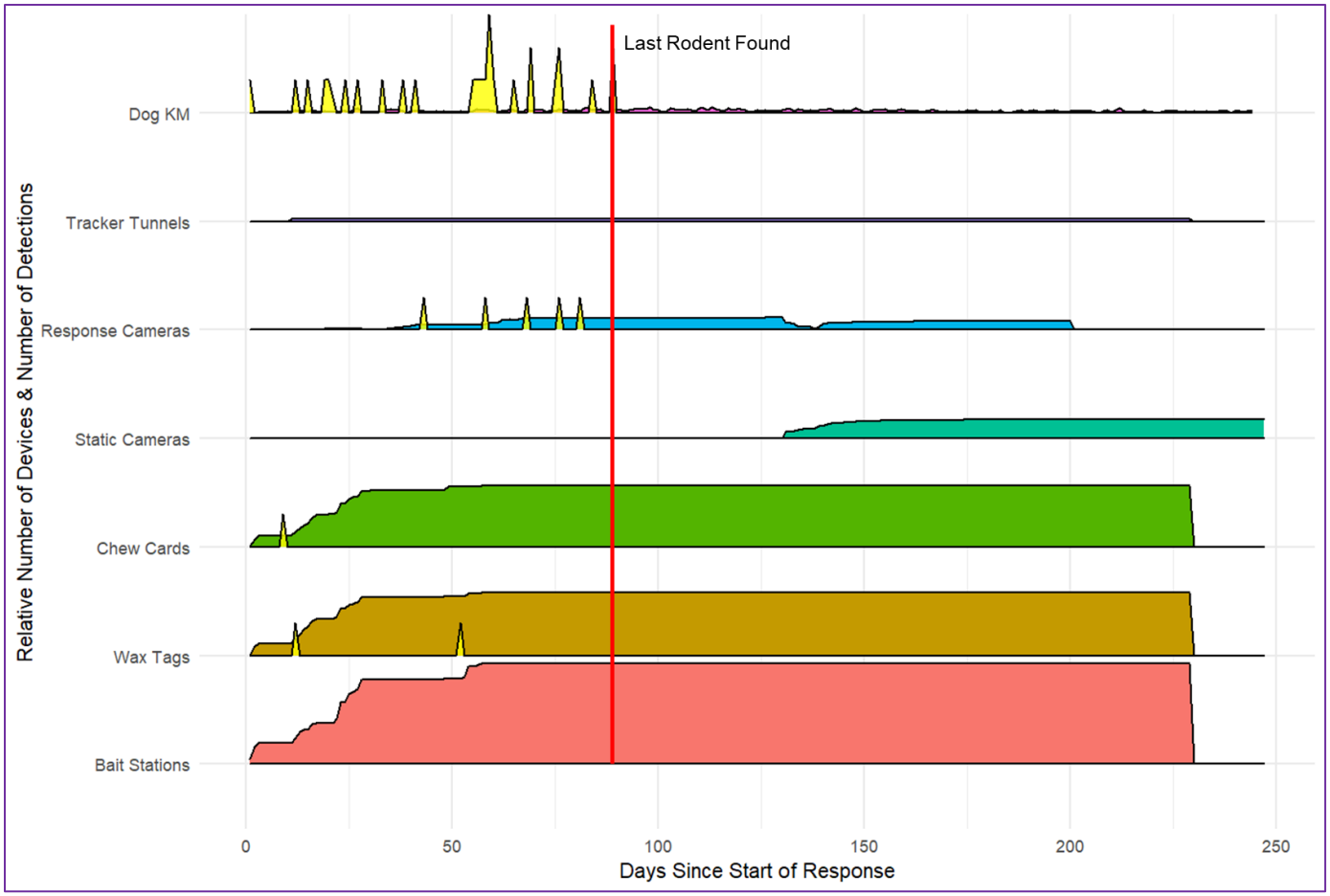


Figure 13: Relative number of devices and detections for various detection devices used on LHI during the RRP. Yellow spikes indicate detections.

These very low rates of interaction rates with detection devices and long durations until interception have been previously recorded for rats introduced to rodent–free islands either accidently or experimentally (Russell, Beaven, MacKay, Towns, & Clout, 2008), and have been attributed to neophobia and/or an abundance of uncontested food resources. Although very few detection devices recorded rat interactions, several were critical discoveries that enabled the Response team to remove rats that may have moved out of the Response area. Therefore, a mix of all possible detection tools should always be part of an incursion or rediscovery response.

Food and lure preferences

Almost all rodent control or eradications on islands are carried out in a situation where rats and/or mice have been present for a long time and are at the maximum population density the environment will support, so intra- and/or inter-specific competition is likely to be intense. Any additional food added to the system will be valued, particularly if it is relatively nutritious compared with what remains and is readily available to all individuals.

In the case of the Response, rat population density was extremely low at about 0.5 rats/ha, and the ecosystem had recovered over the previous 18-months without rodents present in significant

numbers. There was a lot of natural food available, and, in this environment, rats largely ignored lures and baits that are generally regarded as highly palatable where rats have been present for a long time. Anticoagulant pellet baits that were used to remove rats during the REP were mostly avoided until avocado was added to them. Once avocado had been introduced to the bait it resulted in considerable increases in bait consumption and every rat known to be exposed to this lure and bait combination was poisoned.

Lessons Learned:

- Rodents may behave differently when few individuals are present in an environment rich in natural food.
- Avocadoes were apparently highly sought after by rats. If avocadoes are not available, use a food lure that is high in natural fats (Oleaic acid in particular), to attract rats to toxic bait.
- When applying for permits in the initial project planning stage – allow for flexibility in control techniques and adaptability in a response scenario – to ensure that a response scenario can be agile and responsive but not at the cost of compliance.
- Seek permitting amendments where required to facilitate emergency response actions.

6.5 Community and Communications during a Response

Desired Outcome:

The local community are kept well-informed with accurate information during a response scenario and are empowered to assist or lead the program.

Actual Outcome:

The LHI Community were kept informed through existing communication channels during the Rodent Response, with the management team taking on board key learnings from communication learnings from the REP.

The importance of good community relationships cannot be overstated. It should be highlighted that it was a community member who first discovered the rodents in the RRP (as was also the case for the 2023 incursion of Myrtle Rust).

During the 2021 Response in 2021, lessons in community consultation and communication from the REP (Theme 1) were applied. There were already well-established communication channels used during the REP that were re-activated during the response. The community had experience with these communication channels and were aware of the process.

As with the REP, the scheduling and communication for teams to access properties regularly was a critical role to ensuring the response ran smoothly. Experienced personnel from the REP implemented this side of the response efficiently. A dedicated Community Communications role was filled by the NSW NPWS on a rotating roster to prepare and disseminate two community updates per week. This was essential for keeping the community informed about the response progress and significantly reduced the spread of misinformation.

Lessons Learned:

- Open communication is essential to keep the community informed of progress and maintain support for an incursion or rediscovery response.
- An Incursion Response Plan needs to include a Communications Plan for how to engage with stakeholders, particularly local residents, in the event of an incursion or rediscovery.
- In an Incursion Response, a Community Liaison Officer or similar role is essential.
- As field staff are the face of the project, and are constantly interacting with locals, they need to be regularly updated and feel informed. If the teams are not well informed, they are likely to will get a negative response from community during interactions.

6.6 Incursion or Survivors? – evidence from the 2021 Response

Desired Outcome:

If possible, the reason for a rodent rediscovery needs to be determined to ensure the ongoing success of the eradication.

Actual Outcome:

Rats caught during the RRP were highly related to the pre-REP population, although the resulting population had experienced a severe bottleneck of possibly as few as two individuals. Therefore, rats were not eradicated as a result of the initial 2019 eradication program.

At the start of the response, the obvious question was were the rodents detected in April 2021 the result of an incursion, or were they remnant individuals that survived the 2019 REP and remained undetected?

From an early stage, on-island biosecurity staff strongly believed it was a residual population of rodents, but management and expert advisors rejected this hypothesis and thought it was more likely an incursion due to the extended time for rats to re-appear since the REP. Biosecurity was seen to have 'failed' if it was an incursion, and the eradication operation was seen to have 'failed' if it were a residual population. Although the initial on-ground response would be mostly the same regardless, and the answer often cannot be quickly verified (due to genetic testing not being immediate), this is an important question for ongoing improvements to the program. It is important to note here that even an endlessly resourced biosecurity system will always have leaks, and nothing has failed in the event of an incursion. This question was only resolved a few months later by genetic analysis.

By comparing the pre-REP genetic samples with those captured during the Response, Eldrige et al. (2023) concluded that the rats caught in the RRP were rats derived from the pre-REP LHI population. The principal question that arose from the Eldridge et al. report is how rats remained undetected at low numbers within the northern Settlement for 18-months after the last rat was found in October 2019 during the REP. Even a remaining population of just two individuals with an exponential growth trajectory with rate r = 1.01 ± 0.006 (a conservative growth rate for rats given the almost unlimited supply of food and resources) would have generated a population of at least 2800 individuals by April 2021 (Bode, Analysis of proposed Lord Howe Island surveillance network, 2023), which was clearly not the case.

Similarly, post-RRP demographic analysis of the final detected population of ~100 animals suggest it was probably derived from individuals that did not begin breeding before about spring

2020. This begs the question of what caused an apparent delay in breeding activity of about 12 months. Possible reasons are:

1. That the only two individual survivors dispersed widely and did not find each other for a year.
2. The possible two survivors were siblings and initially avoided mating: or
3. The rats' fertility was affected by sub-lethal effects of brodifacoum poisoning, which delayed successful production of young.

This 3rd hypothesis may be supported by the condition of the first adult female located on 16th of April. This individual was one of the heaviest recovered (185g) so was likely relatively old, and dissection revealed only a single uterine scar, and only four embryos, two apparently viable and two which appeared to be 'mummified'. This is a low number of uterine scars and embryos for a female of this weight. When considered alongside the condition of the latter embryos this suggests a problem with reproduction which may have been caused by sub-lethal exposure to an anticoagulant.

Consequently, rodents were not eradicated as a result of the initial 2019 effort. Although population numbers were reduced to an almost undetectable level (to the extent that the 2021 rediscovery was initially considered an incursion), the 2019 program cannot be called an eradication success. The assumption of success was premature, which needs to be considered in future programs.

Lessons Learned:

- Do not prematurely declare success.
- Collection of genetic material before an eradication is essential to confirm whether any later rediscovery is due to reinvasion or remaining individuals.
- While understanding the origin of a new rat population is important for future management decisions, the reason for a resulting eradication remains the same, namely complete removal of the incipient population.
- Do not draw any conclusions about the origin of a population after an eradication until there is reliable evidence to support a theory.
- If it was an incursion, biosecurity improvements may be required (keeping in mind that even a well-resourced biosecurity system will always have leaks). If it was a residual individual, surveillance improvements may be required and planning for final stages of future eradications may need improvement.

6.7 Other Potential Incursion Events

Desired Outcome:

Any potential incursion events are stopped at the first line of defense at mainland departure points, rather than an on-island response.

Actual Outcome:

Multiple potential incursion events have been nullified through an effective biosecurity system at mainland departure points.

The LHI biosecurity system has proven to be a vital safeguard against invasive species, especially pre-border checks. Evidence from multiple voyages showed signs of rodents, including bait take and fresh droppings, despite established baiting and trapping measures on board pre-departure with 50% of vessel inspections between February 2020 and June 2021 resulting in positive detections of potential biosecurity threats upon arrival at LHI. Improvements have been made since this time, but 33% of MV Island Trader arrivals between February 2023 and October 2024 still had biosecurity matter present (Figure 14). While this is a significant improvement on the 93% of checks that returned a positive result in Port Macquarie – inspections and protocols are effective to an extent, they may not fully address all risks during transport.

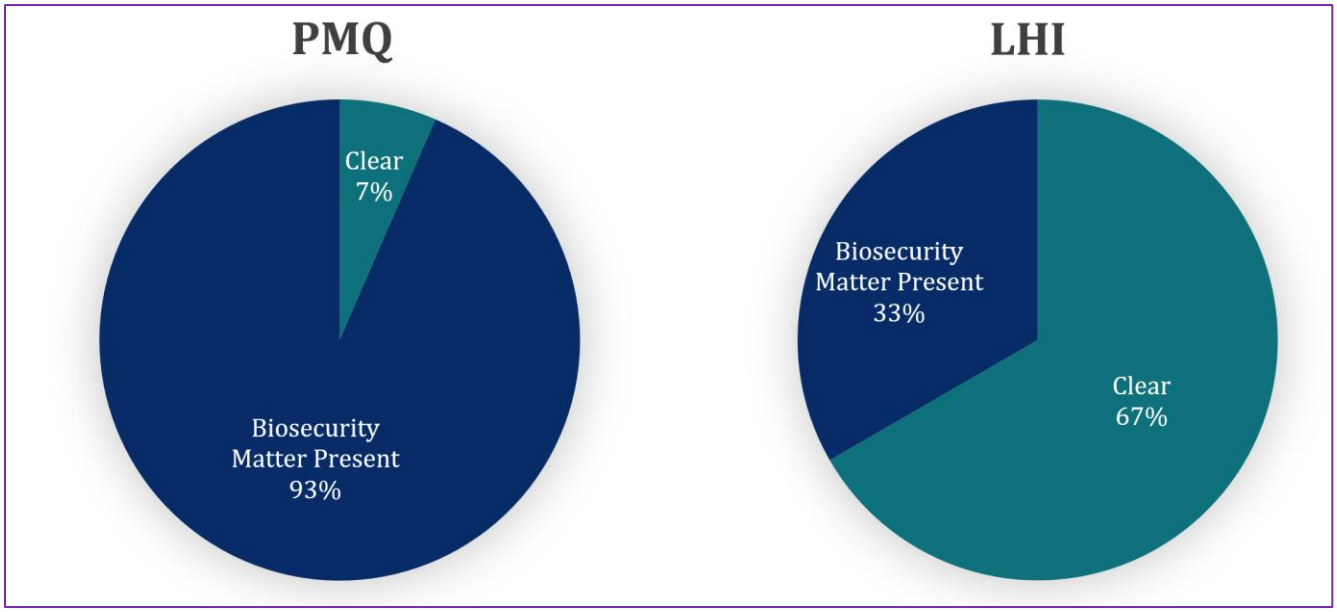


Figure 14: Island Trader Checks (February 2022- October 2024) at Port Macquarie (PMQ) point of departure and Lord Howe Island (LHI) point of arrival.

Additionally, the detection of non-rodent species including mammals, reptiles and amphibians on the Island Trader and its cargo emphasizes the importance of broadening the scope of biosecurity efforts beyond just rodents. The system must be adaptable to a range of potential incursions, with increased awareness of the diverse species that could pose threats to LHI's biodiversity.

While the Island Trader is subject to intensive pre-departure checks and on-board monitoring, airline biosecurity measures need to be equally rigorous due to the potential for pests to stow away in cargo, baggage, or even as contaminants on passengers' clothing. Inspection by of all incoming airline passengers and luggage by biosecurity dogs on LHI helps to alleviate this threat. Despite common indications from dogs, between February 2022 and October 2024, only one incoming commercial flight has found biosecurity matter present (out of ~1100 inspections – or a rate of detection around 0.09%). This is likely due to storage of luggage and equipment (e.g. golf bags, surfboards) in rodent-infested areas at home (e.g. garage or shed) before coming to the island, resulting in residual rodent scent.

Between February 2022 and October 2024, 84 private vessels were inspected upon arrival at Lord Howe Island, with biosecurity material being detected on two occasions. While the low rate of detections (approximately 2.4%) suggests the system is generally working, the presence of biosecurity risks on these vessels indicates that further improvements are necessary.

Overall, these incidents serve as reminders that while the biosecurity system is robust in many respects, there are ongoing opportunities to refine and improve procedures. Strengthening the consistency of inspections at both ends, increasing the use of technology, and ensuring rapid response capabilities are crucial to safeguarding the island from future incursions.

Lessons Learned:

- Pre-border checks and pre-departure checks, while critical and the most effective control, cannot be solely relied upon to prevent all incursions.
- Ongoing and consistent vigilance is the key to maintaining a rodent-free LHI.
- Even with infinite funding and resources, no biosecurity system is infallible. There will always be leaks, and response scenarios should be planned accordingly.

7 Measuring Success

7.1 Ecological Response Monitoring

Desired Outcome:

There is an effective and well-established program of native species monitoring in place before the eradication operation begins, so that pre-eradication and post-eradication data can be compared to confirm benefits.

Actual Outcome:

A diverse suite of native and endemic species on LHI have been monitored before, during and after the REP, and the ecological response since rodents have been removed has been very encouraging.

Prior to the eradication several organisations established monitoring programs to measure changes in the numbers of species due to the removal of rats. This included the LHIB monitoring of Lord Howe Island woodhen numbers, research on Currawongs by Charles Sturt University, small land snail monitoring by Australian Museum Research Institute, annual bird counts by the LHI Museum and the Biodiversity Benefits Program by NSW DPE.

The results have been extremely positive. LHI woodhen numbers have increased by over 400%, and black-winged petrel breeding success has increased from 5% to over 50% post-rat eradication (O'Dwyer T. , Carlile, O'Neill, & Halpin, 2022). Additionally, several micro snail species, including *Pseudocharopa balli*, which had not been seen for over a century (Hyman, 2021), were rediscovered within three years of the eradication operation.

In addition to this there have been more anecdotal observations by locals after the completion of the REP. Locals are now recording live specimens of the large *Placostylus* snail, black-winged petrels are now nesting in the sand-dunes opposite the LHIB offices, black noddy numbers have increased markedly in the Norfolk Island pines around the Settlement, more micro-bats are being seen than ever before, and large insects are now being seen regularly, including butterflies and crickets. Similarly, fruit production in orchards has increased significantly now that they are not subject to attack by rats.

However, the density of numerous weeds is also increasing in an absence of rodents, which puts extra pressure on the WEP. If a future rodent eradication project is planned, any weed species under control need to have their density driven down to very low levels before the rodent eradication begins.

In a partnership with NSW Department of Planning and Environment (DPE) the "Biodiversity Benefits Program" was established to measure and record the benefits to biodiversity arising from the LHI REP. While much has been monitored, the delay and reduction in original funding for post-REP monitoring on LHI missed potential opportunities to advance understanding of changes and the different pace in which they apply to ecosystem recovery following predator removal. The resulting program targets a selection of key groups/species to quantify the benefits of the REP, including vegetation, invertebrates, seabirds, and landbirds.

The key findings have been that there has been a demonstratable increase in seedlings in the lowlands, the invertebrate populations have increased, and those seabirds monitored before and after, have shown an increase in breeding success. As with any complex systems, which Lord Howe Island's ecology is a good example, there are outcomes that could not be predicted. The significant increase in Woodhen numbers has seen them target new prey. The rise in bush bird numbers would have been expected but not necessarily the changes in their feeding behaviours (such as the LHI silvereyes, *Zosterops lateralis tephropleurus*, now becoming a ground foraging species- previously known for almost exclusive tree-canopy feeding).

While not all native avian species have demonstrated a measurable improvement post-eradication (Carlile, O'Neill, & O'Dwyer, 2024), other aspects of changes from biodiversity monitored prior to the REP have yet to be determined, such as changes in flowering and fruiting of some threatened species and changes in reptile numbers and distribution. However, 96% of local residents in a 2024 Community Survey believe the natural environment as a whole has benefited from the program (Lord Howe Island Board, 2024).

Lessons Learned:

- Measuring the ecological response to an eradication program is very important to show a result for the work undertaken and to provide support for future eradications elsewhere.
- It is crucial to establish a monitoring program before the operation commences, so that a pre-eradication baseline is set, and the positive ecological response after the eradication can be objectively recorded.
- A wide range of species have been monitored before, during and after the REP, but is largely focussed on birds. Some species, such as insects, bats, reptiles, and inter-tidal species could have been monitored as well to give a more comprehensive picture of the ecological response to mice and rat removal.
- Timely post-eradication monitoring funding can provide both an early indication of ecological changes underway within complex systems as well as pointing to better pathways to improve recovery of species. The delay and reduction in original funding for post-REP monitoring on LHI missed potential opportunities to advance understanding of ecosystem recovery following predator removal.
- Partnerships are critical to a monitoring programs success, but a more community-led program may help increase community support for the eradication.

7.2 Socio-economic Outcomes

Desired Outcome:

The eradication does not just benefit biodiversity, but also improves social and economic outcomes.

Actual Outcome:

The REP has delivered substantial socio-economic benefits, boosting the island's economy and tourism.

The benefits of the REP are not just limited to the immense biodiversity benefits outlined above. A survey of the LHI community undertaken in 2024 reveals that 88% of residents believe the removal of rodents has benefitted the Island economy, and 59% believe it has been beneficial for tourism (Lord Howe Island Board, 2024).

As discussed in Section 1.3 (Economy) the main drivers for holiday makers visiting LHI are the natural values of the island – so enhancing these values will in turn improve the island as a prime destination for ecotourism - leading to increased visitor spending on accommodation, food, and activities.

Additionally, the project has benefitted agriculture by reducing crop damage, as well as reducing the impact on personal food supplies, and has provided cost savings on ongoing rodent control (both from private residents and the LHIB). The island has become a focal point for scientific research, attracting funding and expertise from around the world, which in turn creates employment opportunities in research and conservation efforts.

Lessons Learned:

- Benefits of an eradication should not be limited to ecological/environmental benefits.
- Being able to demonstrate anticipated socio-economic benefits will likely further the community support for a project.

7.3 Transitional Progress Check – July 2023

Desired Outcome:

A comprehensive checkpoint, or success check, to confirm eradication success, is undertaken at an appropriate time after the last rodent sign is detected.

Actual Outcome:

An intensive checkpoint program was undertaken on LHI in July 2023 – four years since the REP, and two years since the last rodent sign during the RRP – finding no sign of rodents on the island.

Generally, in temperate or sub-tropical areas, after a rodent eradication is undertaken there is a two-year hiatus before undertaking large-scale detection efforts to confirm operational success (Harper, 2023). To determine a successful outcome, an intensive checkpoint effort (Appendix 4) was made in winter 2023, some two years post the removal of the last known rodent. A total of 954 checks of devices were undertaken. Detection dogs covered 296 properties in the settlement area and covered over 220km of tracks in the PPP.

The checkpoint program comprised analysis of the long-term temporal dataset gathered through the ongoing biosecurity surveillance network on island and as outlined below, and a spatially comprehensive detection effort.

The biosecurity surveillance infrastructure comprises 509 tracking tunnels, wax tags, chew cards, rodent traps, bait stations and 162 field cameras. The detection devices around the airport and jetty are checked weekly as they are regarded as high-risk sites, with the remainder checked monthly for any rodent sign, and other possible invasive vertebrates, such as amphibians, reptiles, and marsupials. In addition to these devices, rodent detection-dog teams have undertaken intensive sweeps of the Settlement and main walking tracks 8-9 times per year since mid-2021.

A thorough rodent detection check was undertaken over three weeks in mid-July 2023. In May 2023, 14 tracking tunnel transects, each with 10 tracking tunnels, were set up across the island so rats could become accustomed with them before activation. Thirty-two detection grids were established and activated with tracking tunnels, cards, and lures. Since biosecurity infrastructure was already present in the Settlement, the focus was on the forested PPP area. Each detection grid had a central point with a trail camera, which operated from sunset to sunrise. Four additional detection devices (2 wax tags and 2 chew cards) were placed 25 meters from the central point, one at each cardinal direction.

Detection-dog searches in the PPP, along walking tracks, and routes used by the LHIB weed team were conducted while the detection grids and tracking tunnels were active. Two detection grids, additional cameras, and a detection-dog team were placed on two sites at the island's southern end by boat due to difficult land access. The tracking tunnels, cards, and detection grid devices were retrieved after at least seven nights in the field. The detection devices and tracking tunnel cards were examined by a rodent ecologist for any signs of rodents. All camera images were initially reviewed manually by a LHIB Biosecurity Officer and the Checkpoint Operations Manager before being sent to Evorta™ for additional AI analysis.

The lack of rodent sign recorded by both the biosecurity program over the prior two years and during the 2023 Rodent Checkpoint and since, gives a high level of confidence that no rodents remain on LHI. This conclusion is further supported by detection probability modeling, which indicates the current surveillance network has a greater than 80% chance of detecting a single rodent by 3.5 weeks post-incursion, and over 90% within 10 weeks (Bode, 2023).

Moreover, the obvious recovery of populations of many different species of endemic and native animal and plants, and the lack fresh rodent predation on fruit, molluscs, seabird eggs, chicks, and reptiles over the past three years also strongly supports the conclusion that no rodents remain.

Further to this, a voluntary survey of the LHI community administered in 2024 (Lord Howe Island Board, 2024) asked residents whether they are confident in the results of the 2023 Checkpoint program, to which 74% of respondents were confident (31%) or absolutely confident (43%) that LHI is currently free from rodents.

Lessons Learned:

- While confirming that the LHI REP was an operational success, this checkpoint does not signal the end of this program, as biosecurity will continue in perpetuity.
- Maintaining this significant environmental achievement will require enhanced biosecurity measures and vigilance to prevent complacency.
- Working with the community for ongoing vigilance and surveillance will be crucial to maintain a rodent-free environment on LHI.

7.4 Defining Success

Desired Outcome:

Success should be clearly and measurably defined at the inception of the project – and should include desired socio-economic outcomes, not just technical eradication and ecological results.

Actual Outcome:

Success of the LHI REP was seen as eradicating rodents from LHI, with biodiversity and tourism benefits, but could have incorporated greater social goals.

After more than 20 years of meticulous planning and research, the 2019 eradication operation, and the 2021 response, LHI achieved a monumental milestone: the successful eradication of two rodent species from the largest inhabited island thus far. This world-first accomplishment was confirmed by the 2023 checkpoint, marking a significant ecological triumph.

However, while the ecological goal was achieved, social aspects of the project continue to resonate within the community and may not be regarded as successful as the environmental outcome. There remains a small amount of opposition to the project within the local community and the LHIB as a result. A focus on collaboration and involvement of the local community from the outset could have increased ownership of the program, reduced friction, and cemented trust. A better situation would have been if the project and methodology had better community input in the first place.

Despite this, at the time of writing the overall support for the project in the community is high (Lord Howe Island Board, 2024) – with many residents, businesses and visitors seeing the immense benefits of eradicating rodents from this unique World Heritage location.

Lessons Learned:

- This eradication was unprecedented in scale for an inhabited island. The project successfully achieved its goal of eradication and garnered significant support from most of the local community. However, future eradication planning should incorporate measures of social success to ensure comprehensive positive outcomes.
- The result is significant for the island's World Heritage status, for island conservation globally, and provides a shining example of what is possible.

Quotes from Lord Howe Island Community Members:

"To be living and working without rodents is mind-blowing..."

"The Island has been transformed by the eradication of rodents. Those benefits may be poorly discernable immediately but multiply and grow daily - becoming more and more obvious as time goes by."

"Return visitors to the Island who have visited here prior to the REP can't believe the change in the flora and fauna."

"Not having rodents is amazing, not only for the residents. The flora and fauna on the island is flourishing again."

From:
Community Survey: Lord Howe Island Rodent Eradication Project and Ongoing Biosecurity – Survey administered by the Lord Howe Island Board, (2024).

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Appendix 1: Summary of Lessons Learned

Issue	Desired Outcome	Actual Outcome	Lessons Learned
Theme 1: Community			
1.1 Engagement and Support	The project's success and sustainability are bolstered by strong local community support, early and effective implementation of a community engagement plan, and prioritising genuine, meaningful engagement throughout all phases.	The project was divisive in the LHI community – gathering considerable support, but also facing strong opposition. A failure to understand the scale of community engagement needed, distrust in the robustness of the science behind the project, as well as fragmented and controversial engagement over a long time-period contributed to dissatisfaction and resistance. The development of a Communications Plan, having genuine conversations with residents, hiring local team members, and use of community champions were critical to the project's success.	• Community engagement is a key pillar of project planning and feasibility. Failing to effectively execute engagement risks project failure through project compromises arising from lack of support or active resistance. • Although the likelihood of achieving complete consensus for an eradication in an inhabited area is unrealistic, prior to any actions to proceed with an eradication a social impact plan and community engagement plan need to be developed and implemented. • Technical and social feasibility are equally weighted in inhabited island eradications. Without understanding and planning the social component, implementation of a technical project within an unprepared community environment leads to significant technical compromise and damage to key community relationships. • Conduct a comprehensive and empathetic consultation process using trained facilitators, eradication expertise and local guidance. The outcomes of this process should be used to inform the project options development, feasibility, project management and eradication planning. There is a need to consider very long lead times and budget implications of this. • Community engagement team members should be embedded in the community for an extended period prior to the project or sourced from the local community. • The community needs to be part of the exercise whereby they carefully consider the goal to be achieved and how to get there most effectively. Development and encouragement of the necessary level of community support and nurturing community champions is a crucial element of the Plan. • Failure to identify social issues early in the planning process may result in technical compromises during the implementation phase – potentially creating delays, risk and additional costs for the project. • If the eradication does proceed, the community consultation should influenced the way it will be implemented. This information should guide the development of Property Access Plans – or an overarching Land Access Plan for larger islands where single-property-based plans are not appropriate. • Where a sufficient level of community support is not attained after a suitably comprehensive and effective community consultation program, then consideration needs to be given as to whether to proceed. This will likely be one of the most difficult decisions made during the entire program. • Plan to employ a Community Relations Officer(s) in the community team to provide a variety of regular information packages and updates prior to, and throughout, the operation. • Provide a consistent stream of easily digested information to keep the community well-informed and reduce the likelihood that misinformation will spread. • Keep community champions regularly updated on pertinent project information. This allows them to use their relationships within the community to answer questions and provide up to date details on the project through a trusted source.
1.2 Property Access	All properties involved in the project grant access to all project staff.	Despite initial resistance, by the start of the baiting program all properties had a Property Management Plan in place, but often with complex conditions.	• Without complete bait coverage of the island, the eradication will fail. Property access therefore is crucial to the operations success.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
			• Property access is not a 'one size fits all' approach – genuine consultation will be required and access needs to be managed at the individual property level. • Do not underestimate the complexity of developing individual Property Management Plans. Allow plenty of time before the field operation to consult on these and adapt as project planning progresses. Aim to have all Plans in place well before the field operation begins. • The Operations Manager needs to actively participate in the Property Management Plan process. It's crucial to thoroughly grasp the technical implications of any specific deviations, both on their own, within the broader program and in the context of other individual variations, before finalising plans. • If the eradication does proceed, the community consultation should have genuinely influenced the way the project will be implemented. Use this information to guide the Property Management Plan process to negotiate and determine property access and baiting activities.
1.3 Economy	The eradication operation and resulting biodiversity benefits will contribute positively to the local economy in the long-term and have minimal negative impacts in the short-term.	The LHI REP contributed directly to the island's economy over the usually quiet 2019 winter period. In addition, ongoing economic benefits of the program are predicted to outweigh the costs.	• A Cost-Benefit Analysis for the eradication is a useful exercise if it demonstrates a positive return on investment. It gives justification for the project and will assist in gaining funding and support – but real-world economic benefits may be hard to estimate and quantify. It should consider different time and geographic scales and be revised over time if required. • A Benefits Realisation strategy should be developed to capture benefits over time, informing evaluation and future projects. • Ecotourism opportunities should be investigated for both assisting with the eradication in some way, and after the eradication has been completed. • The economic cost of removing a key threatening process and recovery of over 70 native species has not been costed but should have economic justification on its own.
Theme 2: Planning and Resources			
2.1 Permits and Compliance	All consents are in place well before the field operation begins and all associated agencies understand and support the requirements of the operation.	Late issuance of permits delayed the project progress, increasing cost and reducing trust within the local community.	• Early and ongoing active engagement with regulators is essential to discuss project, risks, mitigation and practicality of permit conditions. Getting DAWR, NSW DPE and EPA representatives to LHI increased understanding significantly. • Waiting for permits to be granted can add significant delays to a project. Approvals preparation and statutory assessment timeframes should be built into schedule. • Allow extra time for permits to be granted, and for any unforeseen permits that arise. Draft all permits at least 2-3 years prior to the operation to allow for review and approval. • Legal expertise early in the planning stages would be greatly beneficial, as would the employment of a Compliance Officer.
2.2 Budget	The operation is tracking within budget at all stages and includes a contingency that covers unforeseen hurdles.	The LHI REP ran over-budget and did not have sufficient contingency in place.	• Budgets need to be routinely revised, and variations requested in advance. • Spending needs to be proactively monitored throughout the program. • Funding increases linked to revised budgets at project gateways as risks are understood and mitigated. • Develop a comprehensive Feasibility Study at the outset, with a realistic and detailed budget with at least 50% contingency to allow for additional unexpected costs. This should be developed by experienced eradication and community engagement practitioners with a review of any previous inhabited island eradication budgets.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
			• Plan for delays and the associated additional costs these will incur.
2.3 Project Management, Planning and Governance	The project is supported by associated Government entities and is effectively managed by people and agencies with good relationships and understanding of the program's complexity – including the needs of the community, permitting/legal requirements and technical implementation. There are clear channels of communication.	The project suffered from a combination of regulatory, operational, and governance challenges. Proactive risk management, early planning, and improved communication with stakeholders could have significantly enhanced the project's development.	• Clearly defined governance and reporting structures from the outset provide transparency and accountability. • Senior managers, community leaders, and government representatives must fully understand the project's principles and community needs, ensuring comprehensive support. • Identify and engage influential community leaders early, maintaining regular communication to build trust and gain community-wide support. • Project managers should cultivate strong relationships with government and community leaders to facilitate consents, provide high-level support, and project a united front. • Governance bodies should include representatives with expertise in ecological, social, and financial aspects, and have clear oversight of project milestones and budget. • Individuals on the governance body must have specific responsibilities regarding achieving project milestones, and budget supervision. They must have the ability to directly advise the project lead of any possible problems that are occurring. • Early access to legal and planning support can streamline consent processes and address potential challenges. • Non-project staff must be fully briefed on the project's requirements and how their roles contribute to its success.
2.4 Staffing	The operation has adequate, suitably experienced, and continuous staffing, plus contingencies, that employs locals, has a comprehensive resourcing and training plan, a streamlined contracting process, and a robust team governance and structure.	The LHI REP employed a significant amount of the local population, but staffing and recruitment were key issues in the program, with a short recruitment timeframe, lack of some areas of expertise, and inadequate staff redundancy.	• There were considerable benefits to employing local staff, including project ownership and trusted communication channels. • Recruitment was a time-consuming exercise. Engage a contractor to recruit and train staff or outsource resourcing the project entirely. • There needs to be a clear organisational chart that clearly states roles, responsibilities and titles. This may need to evolve as project's progress and change. • Build in redundancies to each role. • Staff continuity is important, especially in management roles. Plan to have experts on-site early and leave late. • The community liaison needs to be well-resourced, with a trusted local person acting as a Community Liaison Officer, working alongside a Project Manager (Community) and consider engaging a dedicated technical law expert. • Engage Volunteers early. They provide a morale boost, increase work quality/rate, and help to reduce costs, while providing desirable experience to people in the industry. • Build a core team of excellent communicators to give better core understandings of community values and attitudes and make working with the community more productive. • Prioritising mental health and wellness through proactive monitoring and support ensures the well-being of all team members, creating a healthier and more resilient workforce. • Provide mental health resources for staff working on the project. • Clearly defined roles and targeted recruitment ensure the team has the necessary expertise and accountability. • Managing workloads and building redundancy is crucial for maintaining performance and preventing burnout.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
2.5 Impacts on Business as Usual	The project is successfully run alongside business-as-usual (BAU) and key business functions continue uninterrupted during the operation.	The REP caused significant disruption to BAU for the LHIB and administrative teams were under resourced.	• It is easy to underestimate the impact of such a complex project on BAU activities. • Consider externally contracting the entire project so BAU can continue. • Additional administrative support should be brought on as part of the project. Do not underestimate the resourcing required to manage this workforce. • Leverage larger organisations and project partners resources where possible.
2.6 Data Management and GIS	An accurate, efficient, and user-friendly means for mapping and monitoring of field devices is in place, and has been trialed, well before the operation begins.	Field devices were accurately placed on respective grids, enabling complete bait coverage. Data capture devices were available for all field staff to record the establishment and servicing of bait stations.	• The challenges faced on Lord Howe Island (lack of cell phone coverage, terrain difficulties) are not unique to this location and will need to be thoroughly investigated and systems tested well in-advance of the program beginning. • Good communication of the requirements for the ground operation between the Ground Operations Manager and GIS technician(s) with eradication experience was essential during the trial and development stages some 12 months before the field operation commenced, and during the operation. • Good support from the software and hardware providers was essential to have a robust, user-friendly system in place. • Accurate and timely mapping (i.e. overnight turnaround) was essential for the Ground Operations Manager and Community team to know how each baiting round was progressing and respond to any shortfalls in bait coverage. • Contract experienced GIS technicians with experience in eradication or large pest control projects, as they will be better suited to understanding and providing a service tailored to the requirements of the operation. • Undertake trials of the proposed GIS and data capture systems at least 12-18 months prior to commencement. • Ensure the data capture system is user-friendly, intuitive, and able to be modified to encompass changes to data requirements at different stages of the operation.
2.7 Procurement	A well-resourced, well-stagged, clear, and user-friendly procurement program is in place well before the field operation begins. Sufficient storage space is available to receive, record and store purchases.	The scale of the range of goods and storage required was underestimated. As was the administrative burden to run the process.	• Procurement activities need to be well-resourced. • In remote island settings, logistics are significantly more complicated. Planning should consider limited transport schedules, potential weather disruptions, and the need to build extra lead time into procurement and shipping processes. Having contingency plans in place for delayed or missing items is essential. • The procurement process and clarity of budget delegation needs to be well-established before proceeding with recruiting staff. • Sufficient secure storage needs to be available early in the eradication planning stages. • Procurement at the stores level needs a dedicated staff member to receive, record and store supplies, and be charge of disbursement of supplies.
2.8 Accommodation	Ample suitable accommodation is available to house all external staff for the duration of the operation.	Accommodation was always constrained during the operation and was often expensive.	• Create an accommodation strategy if working in a remote area. • Secure long-term accommodation for staff well before the operation starts, with a flexible refund policy in case of delay. • Consider building additional accommodation that can be used in future projects or setting up temporary accommodation for the duration of the project. • If commercial accommodation is required, book refundable or transferrable options to allow for unforeseen delays.
Theme 3: Technical Implementation			

Issue	Desired Outcome	Actual Outcome	Lessons Learned
3.1 Hand Broadcast	Hand-broadcast is used in areas where it is safe to do so, and it is required to ensure complete bait coverage.	Hand-broadcast was used to overlap between areas of aerial bait application and bait stations, and in areas where highly accurate bait application was required.	• Hand-baiting is significantly more labour-intensive than aerial baiting but is less labour-intensive than bait stations. • Hand-baiting is useful in areas where highly accurate bait application is required. • Do not assume that the community will accept hand broadcast as an appropriate method even if the science says it is safe. Legitimate concerns will remain, and these should not be overlooked or dismissed.
3.2 Bait Stations	If required, an effective network of bait stations is deployed and serviced efficiently.	A complex network of bait stations, requiring multiple minor operational changes, were used in the LHI REP.	• Components of the ground operation not previously encountered in rodent eradication operations on uninhabited islands contributed to significantly more operational complexity. These included the need to bait all the residents' properties, inside their buildings and roof spaces, along with public amenities such as the school and playing fields. • Where possible reduce or eliminate the area or need to ground bait. Ground baiting, particularly the use of bait stations, significantly increases the cost and complexity of an eradication operation. • Bait stations take a significant amount of time and staffing to establish and service, but the cost of not having community support is likely greater. • Strive to remove or isolate all stock/chickens from the island for the duration of the operation and immediately after, to reduce the areas requiring bait stations. • Minor jobs, like sticking barcodes to bait stations, are often overlooked in the project planning stages, but need to be factored into the scheduling to ensure the operation proceeds on time. • Bait stations were an effective method for eradication of mice, but not for complete eradication of rats. Bait station avoidance by a small percentage of rats was evident in the latter stages of the REP ground operation.
3.3 Aerial Baiting	Where it is logistically possible and safe to do so, aerial baiting is used in a rodent eradication.	Aerial baiting was used successfully across most of LHI during the REP.	• Aerial application is the only feasible method to distribute the bait safely and effectively across mountains and thick forest while ensuring that every rodent has an opportunity to find and consume enough bait in a short period of time. • Aerial baiting is generally not appropriate in populated or residential areas. • Inclement weather will add to standby time costs – ensure extra redundancy is in place in the budget for this.
3.4 Tasking and Servicing of Field Devices	Servicing of field devices is undertaken efficiently and effectively across all land tenures.	Property access and social complexities underpinned issues with tasking of staff and servicing of field devices.	• Social complexities can easily impact operational implementation. • Local staff and their personal relationships are crucial to project success. • Involve a Community Planning Team (CPT) early in the process to avoid overpromising and ensure commitments can be met. • Involving the CPT in rostering ensures the right people are available for property access. Additionally, managing the pack-down schedule through the CPT maintains consistency and efficiency. • Leveraging local knowledge and coordinating daily actions are essential for ensuring ground operations goals and actions are centralised and tracked. • Effective data management, including GIS support and mapping, is crucial for accurate planning and decision-making.
3.5 Waste Management	A Waste Management Plan is in place to reduce waste or alternative food sources for rodents, as well as removing carcasses during the operation.	A significant amount of alternative food and shelter for rodents was removed from the island in a successful campaign with leaseholders, and a large number of rodent	• Reduce shelter sites for rodents well before the field operation. • Reduce waste or food sources for rodents as early and as much as possible. This is alternative food to the rodent bait and does not include natural food (e.g. insects/molluscs and seeds/fruit of native plants). This includes

Issue	Desired Outcome	Actual Outcome	Lessons Learned
		carcasses were collected from the settlement area.	compost, stock/chicken food, vegetable gardens, fruit on trees/ground. Dispose of this waste so rodents do not have access to it. • Develop and implement a waste management plan well before the operation, so the community have plenty of time to adjust.
Theme 4: Environment			
4.1 Human Health	Impacts of the operation on human health are eliminated.	Human health impacts of the LHI REP were identified as minimal early in the process and were successfully managed during the operation.	• An Environmental Health Risk Assessment will likely be required by an eradication operation taking place within or near a human settlement. • Do not assume that a scientific study will put all people at ease. People have genuine concerns and these need to be listened to, not dismissed. It is one thing to have the toxicity level documented in a scientific study, it is another thing to be comfortable with your child potentially consuming toxic bait on a remote island.
4.2 Non-target Species	Non-target impacts are managed to an acceptable level.	Non-target impacts of the LHI REP were identified early in the process and any likely significant impacts were successfully managed during the project.	• An acceptable level of non-target impacts should be established at a population level. The non-target impacts during the operation will be greatly outweighed by the benefits of eradicating a key threat. • Captive management of particularly susceptible threatened species may be more appropriate in the long-term, and more palatable to the public, than accepting losses. • Undertake comprehensive bait deployment trials using non-toxic bait early in the planning process to identify possible bait uptake by non-target species. • If deemed appropriate, plan for captive management of non-target native species at high risk from the operation early in the planning process and have the infrastructure and management agency in place well before the operational phase of the eradication begins. • Partnerships with captive-management institutions will be critical. Skills and experience in this area are a necessity before attempting captive-management of threatened species.
4.3 Marine	There are no significant marine impacts from the eradication, and the local community that consume marine species are confident in the results of monitoring.	The LHI REP showed no significant impacts on seawater and freshwater. Residual brodifacoum had been detected in a small number of fish species but is no longer at a detectable level.	• Monitoring of environmental impacts on the marine environment will be required, from both a compliance and social perspective. • A robust monitoring program for the marine environment needs to be implemented and followed. • Do not assume that residents will be confident in the results of monitoring. Remember that these are people's lives and livelihoods.
4.4 Livestock	The impacts of the eradication on livestock are eliminated, and livestock numbers are either nil or as small as possible during the implementation stage.	Most cattle and chickens were dispatched from the island for the operation, and adjustments were made to accommodate the remaining animals.	• Develop a livestock strategy early in the planning phase of the project and engage affected stock owners regarding preferred and alternative strategies. • Develop contingency plans in case of changes to plans. • Strive to remove all stock/chickens from the island for the duration of the operation and immediately afterwards. • Have a designated 'Livestock Officer' or Officers, with experience in managing stock, as part of a community engagement team, depending on project size. • Do not underestimate the work involved in livestock management. • If livestock are to be returned to the location post-eradication, plan for this well in-advance and be prepared for a potentially complex operation.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
4.5 Domestic Animals	The impacts of the eradication on domestic animals are reduced to zero.	The impacts on domestic dogs were successfully managed during the LHI REP.	• People will have concerns about their pets ingesting bait pellets. The use of bait stations should address this concern – but they should be pegged down, or placed out of reach, to stop dogs disturbing them and accessing pellets. • Every dog should be measured for a muzzle with the dog owners receiving it in advance to try out. This provides time for swaps in muzzle sizes and styles. Each dog owner could revise their decisions as to whether to use the muzzle or not ahead of baiting.
Theme 5: Biosecurity			
5.1 Biosecurity Planning	Biosecurity is part of the eradication planning process, and the community is involved in the development of a biosecurity plan. Before proceeding with an eradication, residents, government agencies, and companies servicing the island should be fully aware of the biosecurity requirements to maintain pest-free status.	A degree of biosecurity infrastructure and processes was in place before the operation began, but limited funding and support for improvements in biosecurity process or infrastructure meant there was there had been several iterations of a biosecurity plan before the conclusion of the eradication operation.	• Engaging local communities from the start and fostering a culture of biosecurity through education and involvement is critical for long-term success. This requires dedicated efforts and resources to build trust and cooperation. • Future projects must ensure that adequate funding is allocated to biosecurity from the beginning. This includes securing funds for necessary infrastructure, technology, skilled personnel and ongoing operations. • Establishing a biosecurity team early in the project timeline is crucial. This allows ample time for planning, training, and the establishment of necessary protocols and infrastructure. This team should continue to carry out biosecurity actions separate to the project to ensure both requirements are covered. • Effective change management strategies, including stakeholder engagement, comprehensive training programs, and consistent communication, are essential. Recognising the need for additional workforce and the effort required to integrate them smoothly into the organisation is crucial to ensure all team members understand and support biosecurity measures from the outset.
5.2 Ongoing Biosecurity Program	Effective, community-supported biosecurity surveillance and quarantine procedures are successfully implemented and funded before the project begins and continue in perpetuity.	Ongoing biosecurity, surveillance and quarantine procedures for LHI are now in-place and funded, as per the LHI Biosecurity Strategy 2022-2024 – but these costs were not fully identified early on.	• It costs more to maintain rodent-free status than it did to achieve it. • Even with unlimited resources, biosecurity is never infallible, an effective program can minimise risk, but never truly eliminate it. An effective biosecurity strategy can greatly minimise this risk. It's important to be prepared for an incursion with a well-considered and regularly tested incursion response plan. • Comprehensive biosecurity infrastructure and processes need to be established well before eradication efforts begin. This ensures that there are effective measures in place to prevent re-invasion and maintain long-term biosecurity. • The biosecurity program on LHI has so far been effective and keeping LHI rodent-free since the RRP, with no known incursions since the conclusion of the program.
5.3 Ongoing Surveillance	A well-resourced surveillance program is permanently present to respond to biosecurity threats rapidly and effectively.	LHI now has an effective ongoing biosecurity surveillance program in place, but it is at a significant ongoing cost.	• An effective biosecurity surveillance program needs to be designed, developed and established during the planning phase of a project, as it will be integral to ensuring, and declaring, eradication success. • Intensive end of project surveillance is required to guarantee project success. The standard timeframe for this is 2 years, but experience and evidence suggest that up to 5 years would be a more realistic period of time to fully guarantee success. • Continuous and ongoing surveillance for invasive species after an eradication operation is an essential component to consider when planning the project, as early as possible. • It needs to be clear to the community from the outset that some level of surveillance will be essential in perpetuity.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
			• Biosecurity surveillance on the island does not preclude the critical need to intercept pest species before they arrive on the island. Effective quarantine is much easier and cheaper as it intercepts the invasive animal before they board the boat or plane.
Theme 6: Incursion / Detection Response – 2021 Rodent Response Project (RRP)			
6.1 Surveillance and Initial Detection	An incursion or redetection after the eradication program is quickly detected due to an effective monitoring program being in place.	A network of detection devices and biosecurity detection dogs were present on island post-REP, but did not detect rodents at extremely low densities.	• Whether an incursion or residual population, be ready with a well-practiced and well-resourced response program. • Rats present at a very low population density along with locations with abundant natural food will largely avoid rodent detection devices, existing removal devices and toxic bait. Monitoring tools such as dog teams and cameras will be essential to the detection of rodents and need to be monitored regularly to maintain effective vigilance. • Project success should not be assumed until it is proven. Moving the focus to incursion pathways at the expense of whole of landscape monitoring may result in failure to detect residual individuals. • Detection dogs were crucial to detecting the remaining rodents, but no single detection method is infallible. Even for low detection ability, all methods have the potential to detect an individual that another method does not. Always use a combination of detection methods as all have their merits. • If a residual population remains from an eradication operation, it is highly likely the surviving individuals will develop an avoidance of existing monitoring devices. Be prepared, with resources and permits, to trial novel methods during a response.
6.2 Response Removal Techniques	In the event of a rediscovery after an eradication, removal techniques are well-understood, well-practiced, and adaptable.	Within six weeks of the rediscovery of rodents on LHI, the response team had developed an effective regime for rat removal.	• Removal techniques during a rediscovery will almost certainly differ to those used during an eradication due to rats being in very low population density with very abundant natural food being available, and development of trap avoidance in a residual population. • As with surveillance, a combination of removal techniques should be used for an incursion. No single method is infallible, and a combination will give the best chance of removing every individual.
6.3 Response Resourcing	Resources are immediately made available for an incursion / residual population response, and held in easily accessible storage for future responses, as per a regularly reviewed Incursion Response Plan.	The 2021 Rodent Response was well-resourced, with support from NPWS and the LHI community.	• Like the planned REP, timely procurement and effective stores management, logistic support and ongoing compliance is essential to maintain the field team and regulatory requirements. • An Incursion Plan and all equipment and permits need to be in place, and at least annual refresher training and tests need to be conducted. • GIS support provided the data that informed the Rodent Response strategy. The operation would have been extremely difficult to manage without it. • Assistance from well-resourced external agencies is a huge asset to a response, but a clear framework and integration structure should be developed outside of a response scenario. • Having trained and experienced field staff expedited the response and truncated a likely re-establishment of rats on Lord Howe Island. Continued training and incursion response exercises will be essential to maintain an effective biosecurity program for the island.
6.4 Rodent Behaviour in a Response Scenario	Behavioural changes in rodents are predicted, where possible, and the program has an adaptive management approach with permitting early in the planning process allowing flexibility in a response scenario.	Unexpected rodent behaviour was observed during the 2021 RRP, and the team successfully adapted the control program in response.	• Rodents may behave differently when few individuals are present in an environment rich in natural food. • Avocadoes were apparently highly sought after by rats. If avocadoes are not available, use a food lure that is high in natural fats (Oleaic acid in particular), to attract rats to toxic bait.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
			• When applying for permits in the initial project planning stage – allow for flexibility in control techniques and adaptability in a response scenario – to ensure that a response scenario can be agile and responsive but not at the cost of compliance. • Seek permitting amendments where required to facilitate emergency response actions.
6.5 Community and Communications during a Response	The local community are kept well-informed with accurate information during a response scenario and are empowered to assist or lead the program.	The LHI Community were kept informed through existing communication channels during the Rodent Response, with the management team taking on board key learnings from communication learnings from the REP.	• Open communication is essential to keep the community informed of progress and maintain support for an incursion or rediscovery response. • An Incursion Response Plan needs to include a Communications Plan for how to engage with stakeholders, particularly local residents, in the event of an incursion or rediscovery. • In an Incursion Response, a Community Liaison Officer or similar role is essential. • As field staff are the face of the project, and are constantly interacting with locals, they need to be regularly updated and feel informed. If the teams are not well informed, they are likely to will get a negative response from community during interactions.
6.6 Incursion or Survivors? – evidence from the RRP	If possible, the reason for a rodent rediscovery needs to be determined to ensure the ongoing success of the eradication.	Rats caught during the RRP were highly related to the pre-REP population, although the resulting population had experienced a severe bottleneck of possibly as few as two individuals. Therefore, rats were not eradicated as a result of the initial 2019 eradication program.	• Do not prematurely declare success. • Collection of genetic material before an eradication is essential to confirm whether any later rediscovery is due to reinvasion or remaining individuals. • While understanding the origin of a new rat population is important for future management decisions, the reason for a resulting eradication remains the same, namely complete removal of the incipient population. • Do not draw any conclusions about the origin of a population after an eradication until there is reliable evidence to support a theory. • If it was an incursion, biosecurity improvements may be required (keeping in mind that even a well resourced biosecurity system will always have leaks). If it was a residual individual, surveillance improvements may be required and planning for final stages of future eradications may need improvement.
6.7 Other Potential Incursion Events	Any potential incursion events are stopped at the first line of defense at mainland departure points, rather than an on-island response.	Multiple potential incursion events have been nullified through an effective biosecurity system at mainland departure points.	• Pre-border, pre-departure checks, while critical and the most effective control, cannot be solely relied upon to prevent all incursions. • Ongoing and consistent vigilance is the key to maintaining a rodent-free LHI. • Even with infinite funding and resources, no biosecurity system is infallible. There will always be leaks, and response scenarios should be planned accordingly.
Theme 7: Measuring Success			
7.1 Ecological Response Monitoring	There is an effective and well-established program of native species monitoring in place before the eradication operation begins, so that pre-eradication and post-eradication data can be compared to confirm benefits.	A diverse suite of native and endemic species on LHI have been monitored before, during and after the REP, and the ecological response since rodents have been removed has been very encouraging.	• Measuring the ecological response to an eradication program is very important to show a result for the work undertaken and to provide support for future eradications elsewhere. • It is crucial to establish a monitoring program before the operation commences, so that a pre-eradication baseline is set, and the positive ecological response after the eradication can be objectively recorded. • A wide range of species have been monitored before, during and after the REP, but is largely focussed on birds. Some species, such as insects, bats, reptiles, and inter-tidal species could have been monitored as well to give a more comprehensive picture of the ecological response to mice and rat removal.

Issue	Desired Outcome	Actual Outcome	Lessons Learned
			• Timely post-eradication monitoring funding can provide both an early indication of ecological changes underway within complex systems as well as pointing to better pathways to improve recovery of species. The delay and reduction in original funding for post-REP monitoring on LHI missed potential opportunities to advance understanding of changes and the different pace in which they apply to ecosystem recovery following predator removal. • Partnerships are critical to a monitoring programs success, but a more community-led program may help increase community support for the eradication.
7.2 Socio-economic Outcomes	The eradication does not just benefit biodiversity, but also improves social and economic outcomes.	The REP has delivered substantial socio-economic benefits, boosting the island's economy and tourism.	• Benefits of an eradication should not be limited to ecological/environmental benefits. • Being able to demonstrate anticipated socio-economic benefits will likely further the community support for a project.
7.3 Transitional Progress Check	A comprehensive checkpoint, or success check, to confirm eradication success, is undertaken at an appropriate time after the last rodent sign is detected.	An intensive checkpoint program was undertaken on LHI in July 2023 – four years since the REP, and two years since the last rodent sign during the RRP – finding no signs of rodents on the island.	• While confirming that the LHI REP was an operational success, this checkpoint does not signal the end of this program, as biosecurity will continue in perpetuity. • Maintaining this significant environmental achievement will require enhanced biosecurity measures and vigilance to prevent complacency. • Working with the community for ongoing vigilance and surveillance will be crucial to maintain a rodent-free environment on LHI.
7.4 Defining Success	Success should be clearly and measurably defined at the inception of the project – and should include desired socio-economic outcomes, not just technical eradication and ecological results.	Success of the LHI REP was seen as eradicating rodents from LHI, with biodiversity and tourism benefits, but could have incorporated greater social goals.	• This eradication was unprecedented in scale for an inhabited island. The project successfully achieved its goal of eradication and garnered significant support from most of the local community. However, future eradication planning should incorporate measures of social success to ensure comprehensive positive outcomes. • The result is significant for the island's World Heritage status, for island conservation globally, and provides a shining example of what is possible.

Appendix 2: Suggested Support Structure for an Eradication

Prepared by Grant Harper – Biodiversity Restoration Specialists

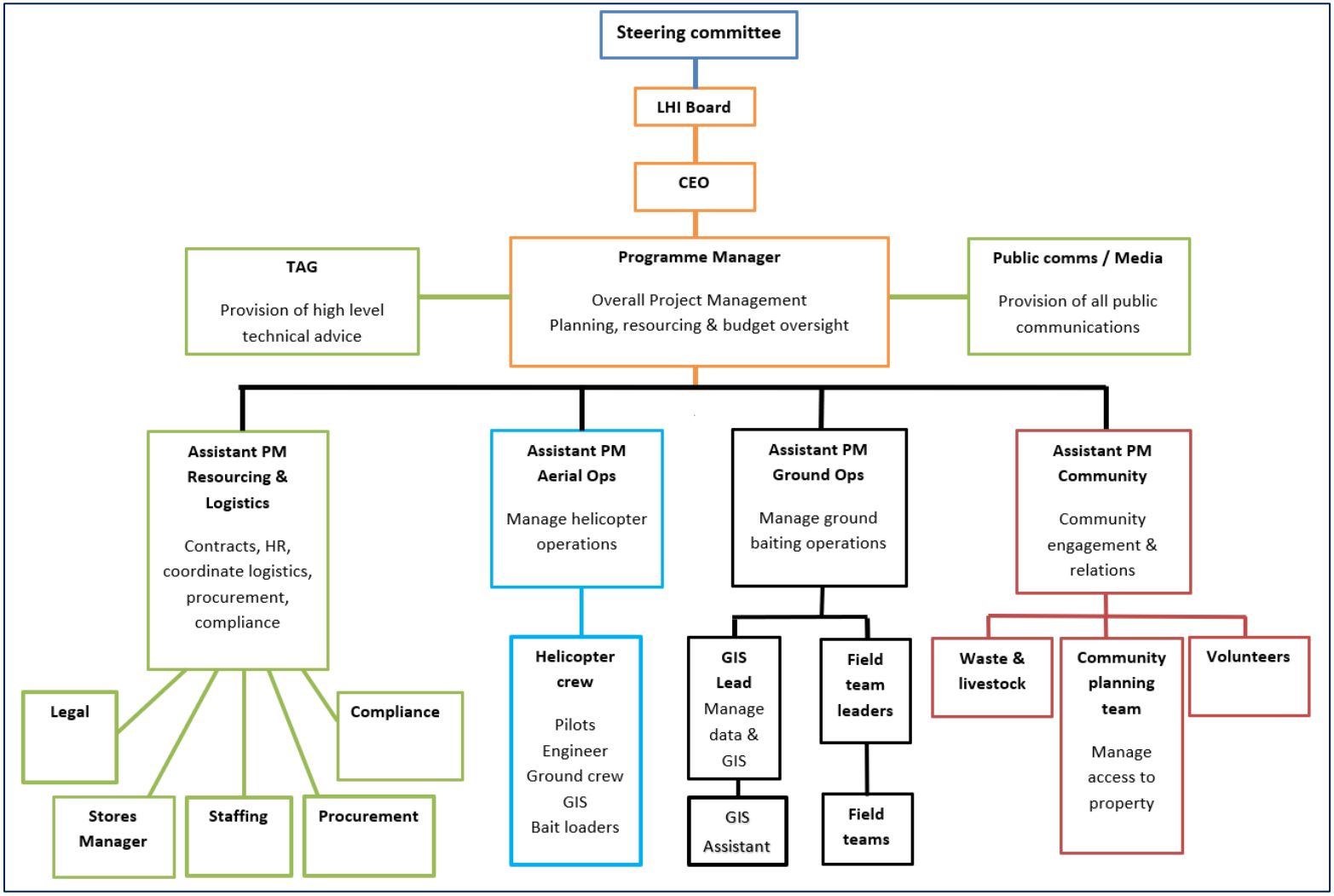


Figure 2: Suggested staff structure for future inhabited island eradication operation

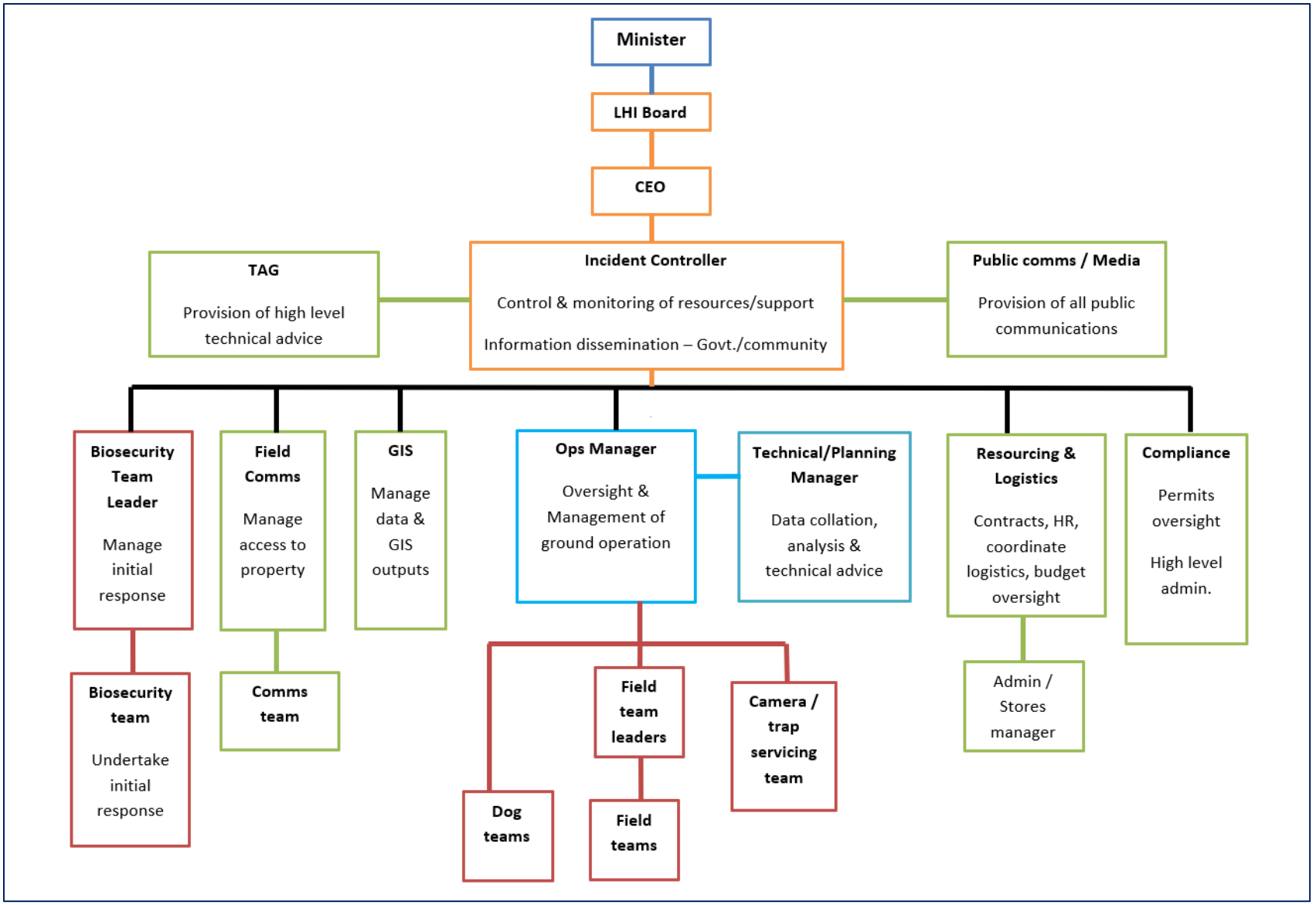
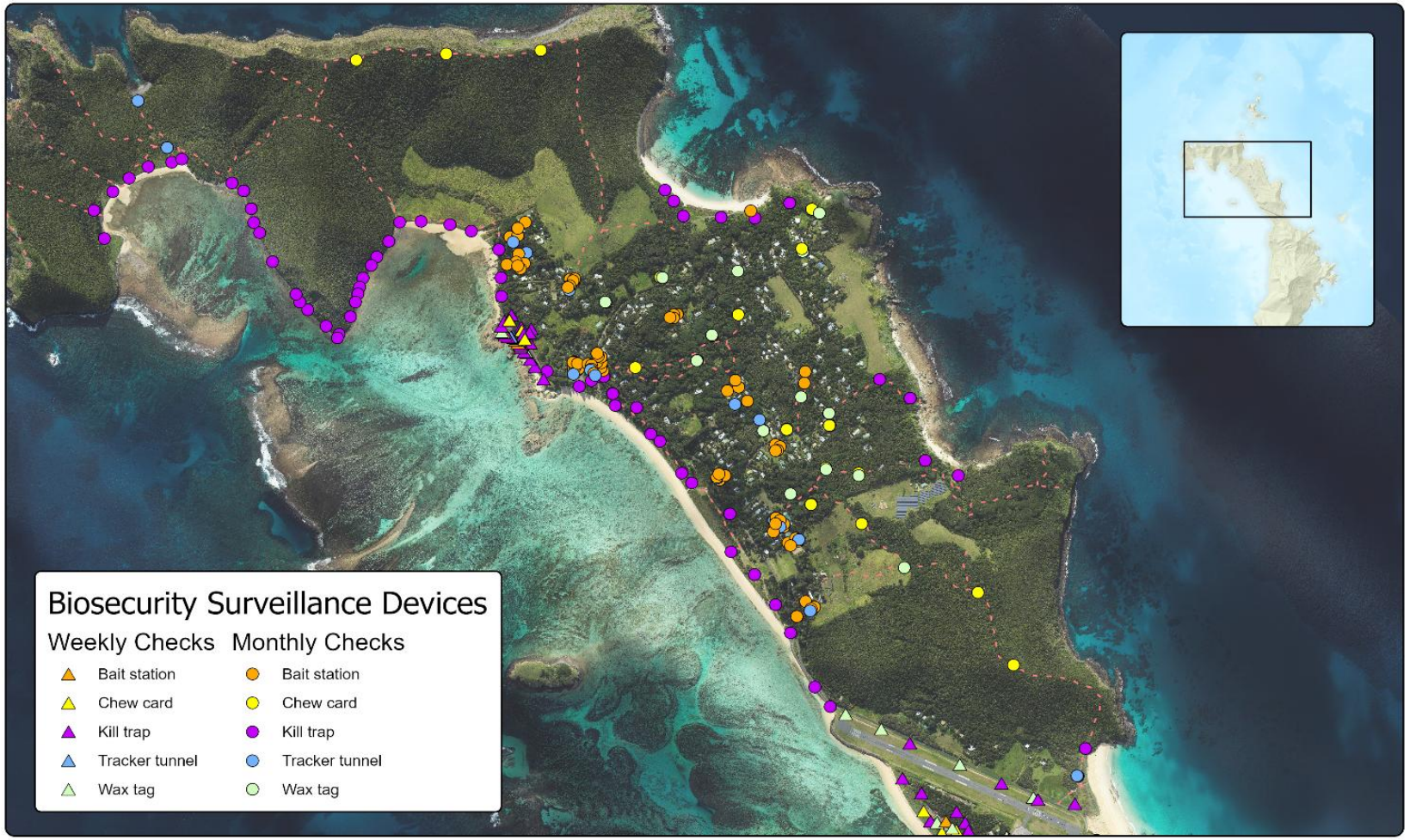


Figure 3: Suggested staff structure for future response scenario.

Appendix 3: Biosecurity Surveillance Network



Scale at A4 = 1:18,481
MGA 94 - Zone 57

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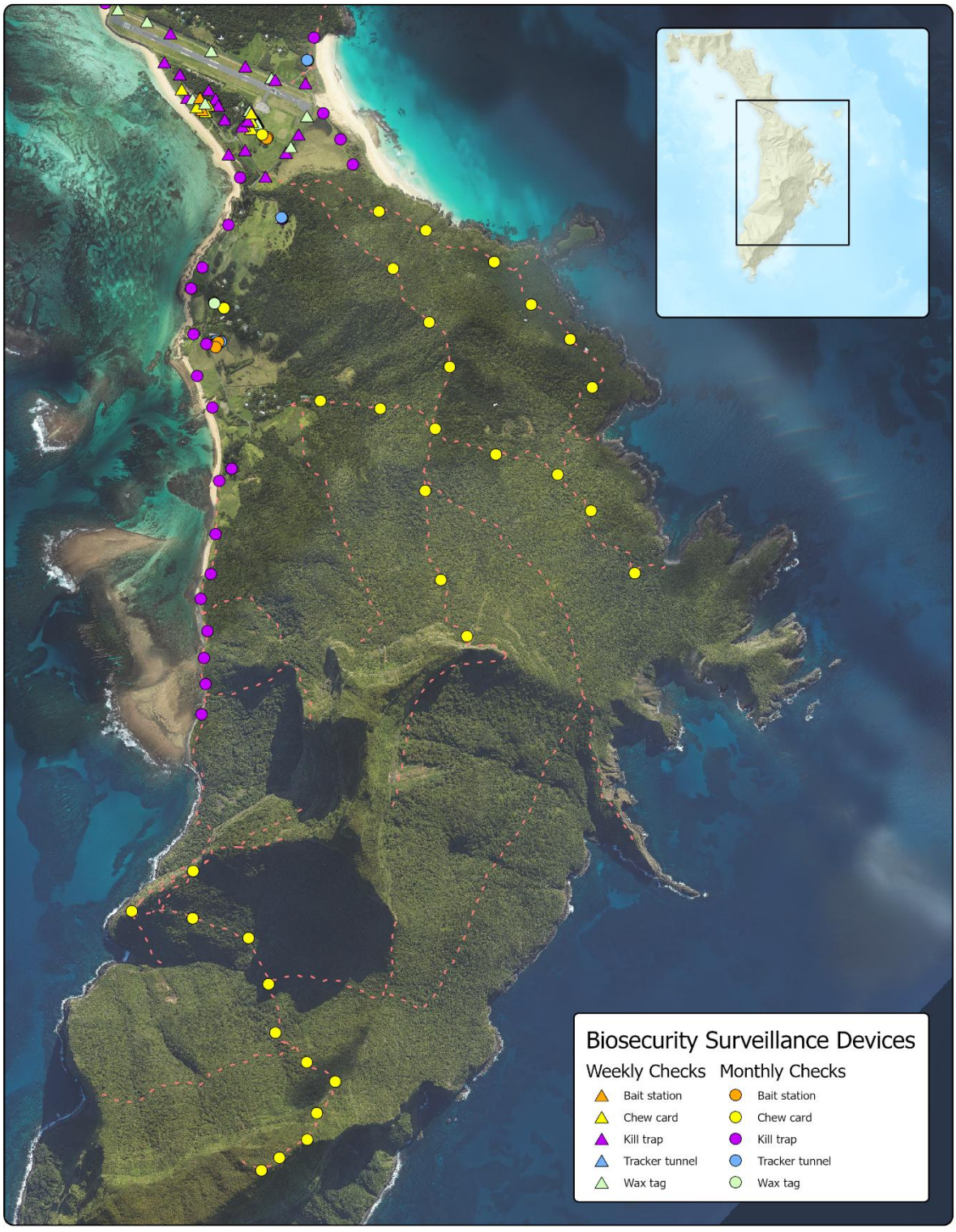
Biosecurity Surveillance Network - North

Lord Howe Island Board
Created on: 11/10/2023

0 500 m N



Scale at A4 = 1:21,685
MGA 94 - Zone 57

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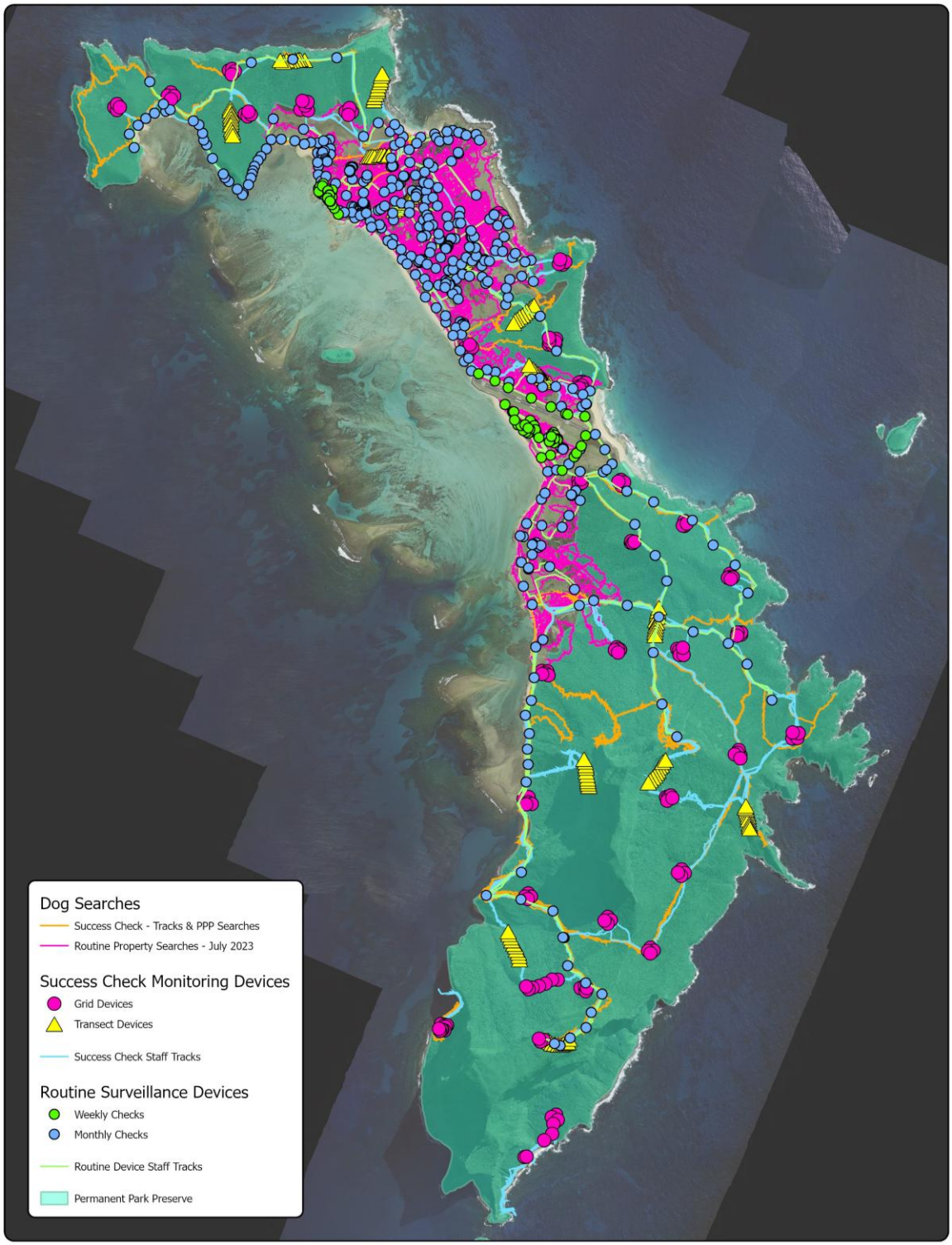
Biosecurity Surveillance Network - South

Lord Howe Island Board
Created on: 11/10/2023

N

0 500 m

Appendix 4: 2023 Success Check Search Effort



Scale at A4 = 1:38,000
MGA 94 - Zone 57

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All Searches - Lord Howe Island

Lord Howe Island Board
Created on: 2/08/2023

N

0 1 Km

Routine Dog Searches

296	288
Property Searches	Settlement Blocks Searched

Success Check Dog Searches

28
Tracks & PPP Searches

Overall Success Check 2023 Search Effort

Routine Surveillance Devices

Device Checks (July 2023)

Device	Monthly	Weekly	Total
Bait station	330	36	**366**
Kill trap	85	126	**211**
Camera	162		**162**
Chew card	59	52	**111**
Wax tag	19	55	**74**
Tracker tunnel	16	14	**30**
Total	**671**	**283**	**954**

Success Check Surveillance Devices

Success Check Device Checks

Device Type	Devices	Total Active Days	Av Days Active
Tracking Tunnel	140	973	7.00
Wax Tag	75	551	7.35
Chew Card	74	553	7.47
Camera	38	284	7.47
Total	**327**	**2361**	**7.24**

Dog Search Effort

Search Area	Dog KM	Dog Hours
Dog Search - Properties	348.40	178.83
Dog Search - PPP Tracks	220.34	104.89
Total	**568.74**	**283.72**

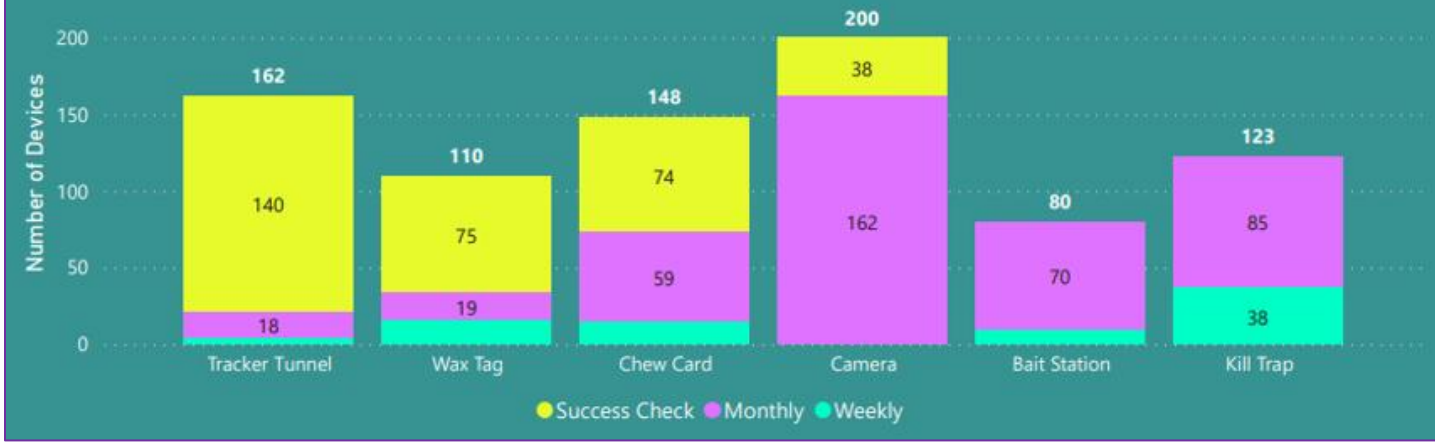
Total Device Checks - July 2023

Device Type	Success Check	Monthly	Weekly	Total
Wax tag	75	19	55	149
Tracker Tunnel	140	16	14	170
Chew card	74	59	52	185
Camera	38	162		200
Kill Trap		85	126	211
Bait station		330	36	366
Total	**327**	**671**	**283**	**149**

Staff Search Effort

Work Type	Staff Hours	Staff KM
Success Check Devices	421.28	350.45
Dog Search - Properties	152.58	191.51
Dog Search - Tracks & PPP	104.89	138.57
Routine Device Checks	69.00	91.43
Total	**747.75**	**771.96**

Combined Surveillance Device Types - July 2023



Snapshot of the intensive search effort undertaken during the 2023 Transitional Checkpoint Program