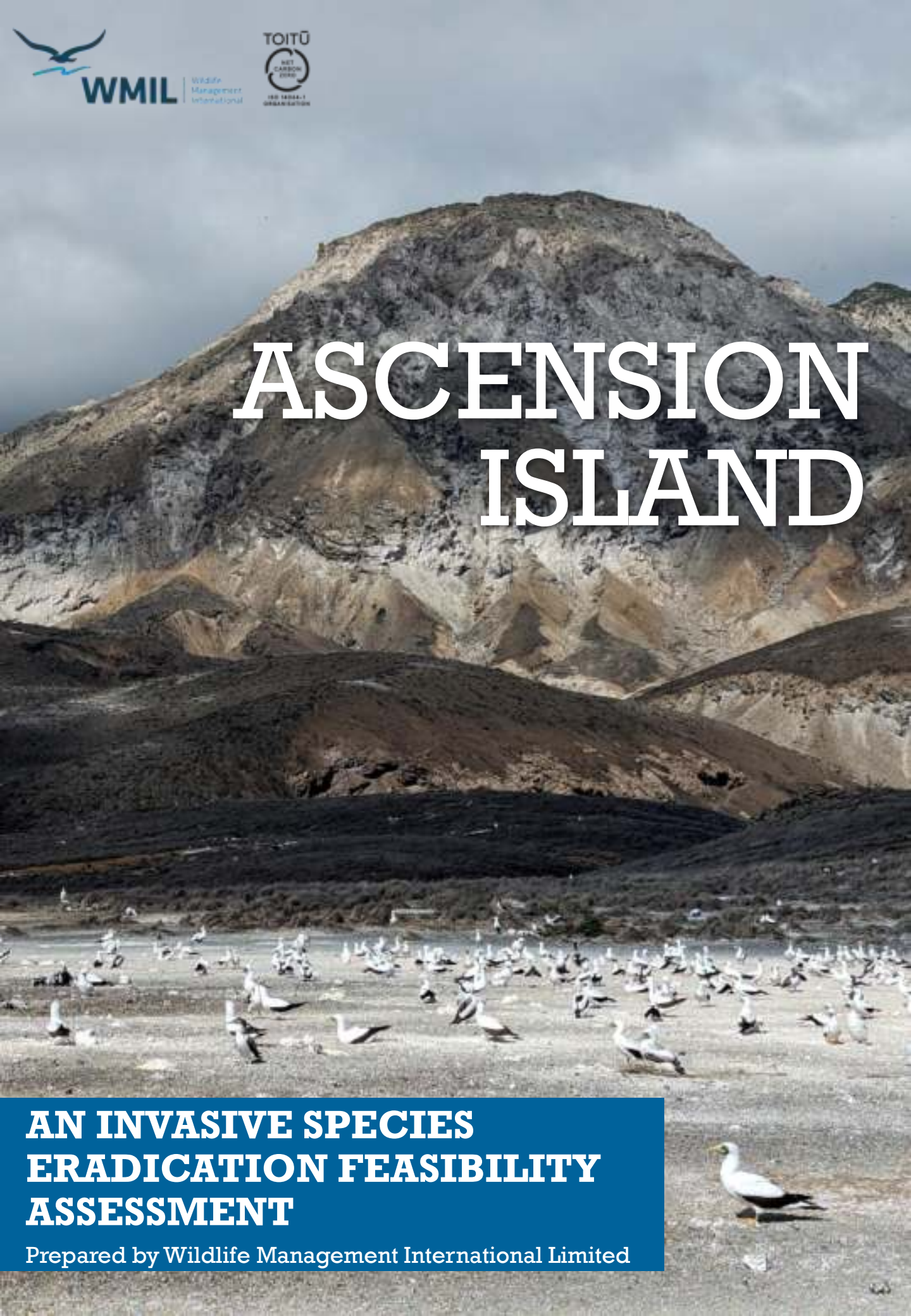

ASCENSION ISLAND

AN INVASIVE SPECIES ERADICATION FEASIBILITY ASSESSMENT

Prepared by Wildlife Management International Limited

A Feasibility Study for the Eradication of Invasive Species on Ascension Island, United Kingdom Overseas Territory

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This report was prepared by Wildlife Management International Limited for the Ascension Island Government.

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Cover Illustration: Masked booby (*Sula dactylatra*) colony at Letterbox Nature Reserve, Ascension Island. Ed Marshall, WMIL, 2024.

VERSION	DATE	AUTHOR	REASON FOR CHANGE
1	22 April 2024	Bell et al.	First Draft
FINAL	8 September 2024	Bell et al.	Final version following stakeholder feedback

EXECUTIVE SUMMARY

1. Ascension Island, a United Kingdom Overseas Territory (UKOT), is an isolated volcanic island in the central Atlantic Ocean. Its nearest neighbour is the island of St Helena 1,127 km to the south. It is roughly 1,500 km northeast from Africa and 2,200 km west from South America.
2. The Ascension Island Government (AIG) have identified invasive species as one of the main threats to Ascension Island biodiversity, along with climate change, pollution, development and disturbance (Ascension Island Government 2022).
3. The entirety of Ascension Island and its offshore stacks (Boatswain Bird Island Sanctuary) are designated as an Important Bird Area (IBA) (Birdlife International 2023a), harbouring globally important populations of seabirds
4. There are a number of species endemic to Ascension Island that are critically endangered such as Ascension parsley fern (*Anogramma ascensionis*), Ascension spurge (*Euphorbia origanoides*), Feather fern (*Pteris adscensionis*), hedgehog grass (*Sporobolus caespitosus*), moss fern (*Stenogrammitis ascensionensis*), Ascension spleenwort (*Asplenium ascensionis*) and purple fern (*Ptisana purpurascens*). These native plant species are at risk from invasive species.
5. House mice *(Mus musculus),* ship rats (*Rattus rattus*), European rabbits (*Oryctolagus cuniculus*), feral sheep (*Ovis aries*), feral donkeys (*Equus asinus*) and common myna (*Acridotheres tristis*) are all non-native invasive species impacting Ascension Island.
6. A successful eradication of invasive predators, and control of livestock on Ascension Island would result in conservation gains for native biodiversity on the island, as well as reduced costs associated with ongoing damage caused by invasive species.
7. A site assessment was conducted by WMIL between 21 January 2024 and 2 February 2024. During these two weeks WMIL met with local stakeholders, staff and community members to identify issues and concerns about the ongoing presence of invasive vertebrate species on Ascension Island and the proposed eradication or control of these species.
8. The feasibility of eradicating each invasive species was weighed against seven key criteria; technical feasibility, sustainability, political & legally acceptability, social acceptability, environmental acceptability, capacity and affordability.
9. Table A provides a summary of the feasibility for each invasive species. Further details for each invasive species are found from Page 30 (Feasibility Assessment).
10. Costs for each eradication have been included as stand-alone eradication operations. If several invasive species were targeted concurrently, overall savings would be made. However, the cost of these joint multi-species eradication operations would still be significant.
11. Although most eradications on Ascension are technically feasible, all would require significant funding, an improvement in island infrastructure to host large eradication teams, and robust community engagement to ensure support for the proposed eradication.
12. Ultimately any eradication of rats would depend on permission for aerial deployment of bait and would be dependent on suitable ground-based techniques (i.e., hand-broadcast and bait stations) for a significant land area (no-fly zones and residential).
13. The eradication of rabbits would require permission to use toxic bait, with hunting and shooting as secondary methods. The introduction of a disease may also be an option but would require permission from the Ascension Island Government and thorough community consultation. Rabbits could be targeted while the population level is low, reducing the requirement for these more controversial methods to be used.
14. The use of helicopters and/or drones would be required to target specific invasive species (i.e., mice, rats, rabbits). Further investigation and trials into both aerial options would be required to determine seabird interaction and possible brown out conditions.
15. Given the lack of infrastructure on Ascension to house large eradication teams, the availability of suitable vessels to accommodate staff for the duration of an eradication, and transport machinery and other eradication equipment would be needed. Alternatively, accommodating large teams on island may be possible through coordination of Ascension Island Government, United States Space Force and Ministry of Defence.

EXECUTIVE SUMMARY

Table A. *Summary of the feasibility to eradicate key invasive species from Ascension Island.*

Invasive Species	Feasibility	Explanation
House mice	Unfeasible	• Technically feasible using aerial baiting combined with ground-based methods, but dependent on the scale of the ground-based requirements. • Sustainability is contingent on robust biosecurity measures and a commitment from all agencies and residents on the island. • Politically and legally feasible as support ed by local and national agencies on Ascension. • Socially accepted as community and stakeholders showed support for any rodent eradication. • Environmentally acceptable conditional on robust mitigation for risks to non-target species, people, and the wider environment, particularly with aerial application methodology. • Capacity requirements are significant with at least 100 ground staff required. Currently no capacity on Ascension to accommodate teams of this size. • Unfeasible affordability due to costs of £45 million for a stand-alone mouse eradication.
Ship rat	Conditionally feasible	• Technically feasible using aerial baiting combined with ground-based methods. • Sustainability is contingent on robust biosecurity measures and a commitment from all agencies and residents on the island. • Politically and legally feasible as supported by local and national agencies on Ascension. • Socially accepted as community and stakeholders showed support for any rodent eradication. • Environmentally acceptable conditional on robust mitigation for risks to non-target species, people, and the wider environment, particularly with aerial application methodology. • Capacity requirements are significant with at least 35 ground staff required. Currently limited capacity on Ascension to accommodate teams of this size and may require infrastructure improvement. • Conditionally feasible affordability due to costs of £33 million for a stand-alone rat eradication.
European rabbit	Conditionally feasible	• Technically feasible, conditional on the extent of the ground-based requirement and approval to use toxin to target rabbits, with follow-up trapping and hunting. • Sustainability is contingent on robust biosecurity measures and a commitment from all agencies and residents on the island. • Politically and legally feasible as supported by local and national agencies on Ascension. • Conditionally socially accepted as initial discussions with community and stakeholders showed support for the rabbit eradication, but further widespread consultation should be completed to ensure this opinion is valid across the whole community. • Environmentally acceptable conditional on robust mitigation for risks to non-target species, people, and the wider environment, particularly with toxin use. • Capacity requirements are high with ground-based areas requiring up to 35 staff. If rabbits were targeted at the current low population size, a 15-person team would be needed to hunt and successfully target the remaining population. Currently limited capacity on Ascension to accommodate teams of this size and may require infrastructure improvement. • Conditionally feasible affordability due to costs of £7 million for a stand-alone rabbit eradication.

EXECUTIVE SUMMARY

Table A continued. *Summary of the feasibility to eradicate key invasive species from Ascension Island.*

Invasive Species	Feasibility	Explanation
Myna	Conditionally feasible	• Technically feasible, but confirmation of suitable methodology (i.e., avicide, traps, hunting, etc.) using trials would be needed. • Sustainability is contingent on robust biosecurity measures and a commitment from all agencies and residents on the island. • Politically and legally feasible as supported by local and national agencies on Ascension. • Conditionally socially accepted as initial discussions suggests support for the myna eradication, but widespread consultation should be completed to ensure this is valid across the whole community. • Environmentally acceptable conditional on robust mitigation for risks to non-target species, people, and the wider environment, particularly if avicide is used. • Capacity requirements are feasible with 12 people needed to successfully target myna. • Conditionally feasible affordability due to costs of £4 million for a stand-alone myna eradication.
Feral Donkeys	Unfeasible	• Technically feasible using hunting. • Sustainability feasible as donkeys would require human assistance to be returned to Ascension. • Politically and legally conditionally feasible as the donkey situation on Ascension is controversial and would require local Government support. • Socially unacceptable as community members and stakeholders wanted to keep donkeys on Ascension due to the historic and cultural connection. • Environmentally acceptable as proposed eradication methodology impacts limited to disturbance. • Capacity requirements are feasible with a team of 6 specialised hunters with dogs needed to successfully eradicate feral donkeys from Ascension. • Conditionally feasible affordability due to costs estimated at £2.2 million for a stand-alone donkey eradication.
Feral Sheep	Conditionally feasible	• Technically feasible using hunting. • Sustainability feasible as sheep would require human assistance to be returned to Ascension. • Politically and legally feasible as the project has the support of local and national agencies on Ascension. • Conditional socially acceptance as some community members want sheep retained as a food source and hunting activity, whereas others want them eradicated due to nuisance and damage. Widespread consultation would be needed. • Environmentally acceptable as proposed eradication methodology impacts limited to disturbance. • Capacity requirements are feasible with a team of 6 specialised hunters with dogs needed to successfully eradicate feral sheep from Ascension. • Conditionally feasible affordability due to costs estimated at £1.7 million for a stand-alone sheep eradication.

16. Alternative methods, such as predator-exclusion fencing, to protect specific seabird species and//or smaller, more manageable sites should be assessed. This would require further investigation to determine a suitable site(s), methods, and materials required for the successful, long-term placement of any fence.
17. An intensive rodent control strategy needs to be developed and implemented to improve rat and mice control standards, methodology and results on Ascension.
18. Current rodent control undertaken by Environmental Health staff focuses on all residential areas (Georgetown and Two Boats), several of the agency buildings and operational areas, public walking tracks around Green Mountain, and all the roads. Consistent effort across all areas on the island cannot be maintained due to capacity and wide range of responsibilities that Environmental Health staff must manage. Often large areas do not have ongoing rodent control and are only treated when complaints are raised by the community or prior to key public events or seabird or turtle breeding seasons. Additional resources, including new staff members, need to be added to Environmental Health to improve rodent control to improve overall results.
19. Environment Health staff should be trained in international best practice techniques, safe rodenticide handling and use, data recording and analysis and rodent monitoring.
20. Changeable weather patterns has resulted in increased rainfall events on Ascension, which has enabled rodent numbers to irrupt following flushes in vegetation, particularly rain grass. This has led to increased impact on infrastructure, homes, and native species. It is important that rainfall and climate monitoring is undertaken to allow Environmental Health to identify vegetation flushes and successfully target subsequent rodent population increases.
21. There are a number of key recommendations (see Page 72 for further detail):
    a. An intensive rodent control programme for Ascension Island is designed and implemented to improve rodent control until an island-wide eradication can be implemented.
    b. Environment Health undertake bespoke rodent control training covering best practice methodology, rodenticide handling, rodent monitoring and data collection and analysis. WMIL would be able to prepare this for the Ascension Island Government.
    c. Environmental Health capacity is increased by the employment of two new staff and that these new personnel focus their efforts on rodent control.
    d. All agencies undertaking rodent control on Ascension Island coordinate to use the same toxin across the island to prevent bait aversion and resistance developing among the rodent population.
    e. Waste management on Ascension Island is improved, especially using the incinerator to dispose of food waste and repairing the fence around the landfill and ensuring the gates are closed overnight to exclude donkeys and sheep.
    f. Rainfall monitoring stations are established to better predict when and where rodent populations may increase in response to higher natural food availability (vegetation growth) and allow focused baiting effort to be completed to respond to these rodent irruptions.
    g. A detailed construction and project plan should be developed for a predator-exclusion to protect sooty terns at Mars Bay Nature Reserve and other nesting seabirds on Letterbox Nature Reserve.
    h. A detailed biosecurity plan is produced for Ascension Island, covering all invasive species and outlining risks, pathways, prevention, detection and incursion response.
    i. Additional investigation into aerial methods for bait deployment is undertaken, including working with experienced helicopter and payload drone pilots.
    j. Baseline key species monitoring is conducted across a range of habitats on Ascension Island.
    k. Invasive plant management is maintained across Ascension Island.
    l. Invasive species monitoring is undertaken using a range of tools including trail cameras to obtain behavioural information, population abundance and density estimates across the island over time which would provide more information for any future eradication.
    m. Community consultation regarding all possible invasive species eradication is begun to explain eradication requirements and gather information on opinions about invasive species and concerns about future operations.
    n. Feral sheep and donkeys are contained in a management site to reduce their impact on the natural biodiversity of Ascension, reduce invasive plant spread, and improve their welfare.
    o. Funding options for invasive species eradications, particularly an island-wide rat eradication, is investigated by Ascension Island Government.

CONTENTS

INTRODUCTION	5
TARGET SPECIES	11
FEASIBILITY	16
METHODS & OPTIONS	22
CASE STUDIES	60
RECOMMENDATIONS	69
ACKNOWLEDGEMENTS & REFERENCES	71
APPENDICES	79

PAGE 9 *KEY SPECIES*

PAGE 10
TARGET SPECIES

PAGE 16 *FEASIBILITY*

PAGE 69 *RECOMMENDATIONS*

Image:

INTRODUCTION

This report presents expert opinion and scientific evidence regarding the feasibility of eradicating invasive species from Ascension Island.

Overview

The Ascension Island Government (AIG) have identified invasive vertebrate species as one of the main threats to Ascension Island's (herein referred to as Ascension) biodiversity, along with climate change, pollution, development and disturbance (Ascension Island Government 2022). Efforts to mitigate the impacts of invasive species on Ascension have increased over the last 30 years, especially since the United Kingdom (UK) became a signatory on the Convention on Biological Diversity in 1992. Previous studies have been conducted on Ascension to evaluate the feasibility of eradicating feral cats (*Felis catus*) and ship rats (*Rattus rattus*) (Bell & Ashmole 1995), European rabbits (*Oryctolagus cuniculus*) (Bell & Boyle 2008), and common myna (*Acridotheres tristis*) (Allan 2009). Following recommendations from Bell & Ashmole (1995) a feral cat eradication operation was conducted by Wildlife Management International Limited (WMIL) between 2001 and 2004 and was declared successful in 2006 (Ratcliffe et al. 2009). Ship rats were deemed unfeasible at the time and European rabbits remain on Ascension, as well as house mice (*Mus musculus*), common mynas, and feral populations of donkeys (*Equus asinus*) and sheep (*Ovis aries*) that continue to impact upon the islands' native flora and fauna.

It was hoped that after the eradication of feral cats there would be an increase in numbers of native seabirds. While several of Ascensions seabird species recolonised areas of the main island, Hughes et al. (2019) showed that numbers of sooty terns (*Sterna fuscata*) have remained at their pre-feral cat eradication numbers. It is likely to be the result of a meso-predator release that has since allowed rat numbers to increase in the absence of feral cats, which are now impacting on the breeding success of this species (Hughes et al. 2019).

For the eradication of any invasive species to succeed, it must first be deemed feasible against seven key criteria, remain flexible to change, and adapt the tools and methods to suit requirements of the project. It is important to recognize that each project is unique and will face its own challenges specific not only to the island, but also the communities present.

A glossary of terms are given in Appendix 1.

The Goal

The goal of an invasive species eradication project on Ascension is the complete eradication of each proposed target species. The species considered are mice, rats, rabbits, myna, sheep, and donkeys. Which species are finally targeted for eradication or improved control will depend on community support. All species are considered here to provide detailed information on the requirements for eradicating each species, while minimising any adverse impacts on the environment, non-target species, archaeological features and humans. It is hoped that successful invasive species eradication or long-term control will help to restore the islands ecosystem, further protecting the nationally and internationally important biodiversity found here, as well as reduce socio-economic impacts resulting from damage associated with invasive species.

The Justification

The entirety of Ascension and its offshore stacks (Boatswain Bird Island Sanctuary) are designated as an Important Bird Area (IBA) (Birdlife International 2023a), harboring globally important populations of seabirds, including the endemic Ascension Island Frigatebird (*Fregata aquila*). In 2019, Ascension Island was designated a Marine Protected Area (MPA) totalling 445,000 km^2, making it one of the largest MPA's in the world (Ascension Island Government 2021). Ascension, as a United Kingdom Overseas Territory (UKOT), are also a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. Boatswain Bird Island Sanctuary is designated a Site of Special Scientific Interest (SSSI) and Bird Sanctuary.

There are several native plant species endemic to Ascension that are critically endangered such as Ascension parsley fern (*Anogramma ascensionis*), Ascension spurge (*Euphorbia origanoides*), Feather fern (*Pteris adscensionis*), hedgehog grass (*Sporobolus caespitosus*), moss fern (*Stenogrammitis ascensionensis*), Ascension spleenwort (*Asplenium ascensionis*) and purple fern (*Ptisana purpurascens*). These plants are at risk from increased grazing, as well as competition with invasive plant species that are spread by invasive mammals (Ascension Island Government 2015b). Species extinctions resulting from invasive species are known on Ascension, with a species of crake (*Mundia elpenor*) having gone extinct due to predation from feral cats and rats (Birdlife International 2023b).

A successful eradication of invasive species on Ascension would result in conservation gains for native biodiversity on the islands, as well as reduced costs associated with ongoing damage caused by invasive species.

A table of project objectives and outcomes is provided in Appendix 2.

The Site: Ascension Island

Ascension is an isolated volcanic island central in the Atlantic Ocean (8,890 hectares; 7°56'23"S, 14°21'55"W; Figure 1). Its nearest neighbour is the island of St Helena 1,127 km to the south. Ascension is approximately 1,500 km northeast from Africa and 2,200 km west from South America. It is a geologically young island at c. 1 million years old (Jicha et al. 2013), with lava flows and cinder cones common features of its landscape. The summit of Green Mountain, Ascension's highest point, reaches 859 m. Ascension is home to globally significant populations of turtles and seabirds, as well as over 70 endemic species including plants, invertebrates and seabirds such as the Ascension Island frigatebird.

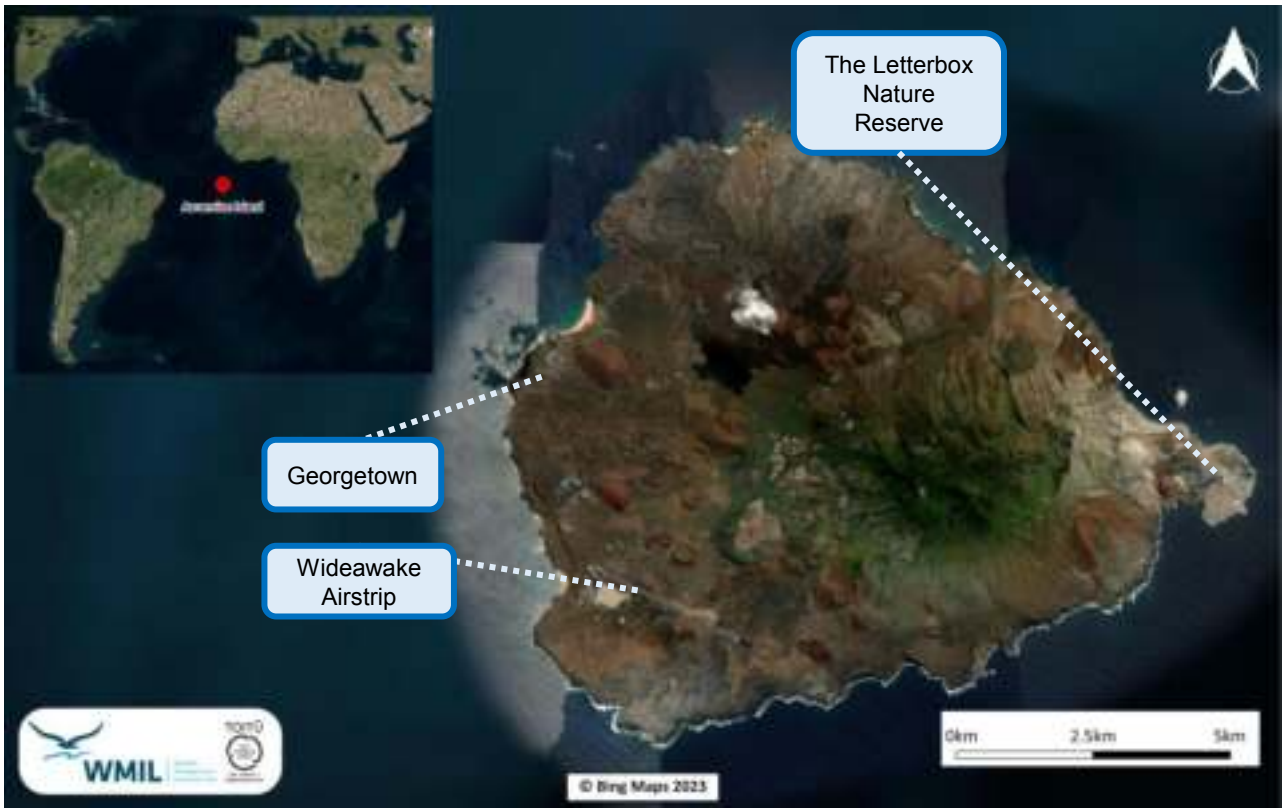


Figure 1. *Ascension Island, with some of the key operational areas such as Georgetown, the Wideawake Airstrip, and the Letterbox Nature Reserve labelled.*

There is a central governance on the island provided by the AIG and the UK Government provides a supportive role. There are roughly 800 people resident on the island throughout the year, all of which are contractors, or the dependent of someone who is, with most being employed either by governmental departments or the UK and US Military. Ascension has two military airbases, one operated by the British Royal Air Force (RAF) and one by the United States Space Force (USSF), and Georgetown pierhead in Clarence Bay.

Ascension has been massively altered by the terraforming of the landscape. Alien plant species have been introduced and established across much of the island, with Green Mountain becoming entirely forested through human-mediated introductions (Duffey 1964). It is estimated that 93.2% of plant species are non-native (Lambdon & Darlow 2008).

The climate is tropical but oceanic, with temperatures that range from 22°C to 34°C (AIG, *pers. comm.*). Annual rainfall at sea level is generally low, with higher annual rainfall occurring on the islands summit, partly due to the creation of a rainforest habitat. There are periods of heavier rainfall typically from January to April.

Due to the presence of endemic species and globally significant populations of breeding seabirds, Ascension should benefit greatly from increased invasive species control or eradication.

The Key Species

One outcome of invasive species eradication or control is the benefit to native and endemic species. With nine Protected Areas as well as the Green Mountain National Park, it can be expected to see native species increase in abundance as invasive species are eradicated or controlled. Click the banners below to view more information on Ascension's native flora and fauna.

Seabirds

Ascension Island is the tropical Atlantic hotspot for seabirds (Appendix 5). Invasive species such as rats will be impacting upon their populations through predation of eggs and chicks.

Invertebrates

Several unique invertebrates are found on Ascension Island, which will be impacted by the suite of invasive pests that are currently found here.

Marine Life

Marine life, particularly turtles, are impacted by invasive species. Rats predate turtle eggs and hatchlings. The effects of island restoration can be far reaching, including improved marine ecosystem health thanks to better nutrient flow.

Endemic Plants

Reduced browsing of trees, fruits and seeds will allow new growth to flourish and provide habitat for native species.

TARGET SPECIES

This feasibility study proposes methods for the eradication of rats, mice, rabbits, and myna, as well as control options for sheep and donkeys. Details of each of these species are discussed in the following pages. It must be understood and communicated to the community that if livestock species are not targeted for eradication or control by the project, there will need to be strict mitigation measures put in place to protect them, and that the stock will continue to impact the local communities and island biodiversity if they are not managed.

Ship rats
Rattus mom

ABOUT	KEY FEATURES	IMPACTS	DIET
Body length: 120-210 mm, Average 180 mm. Weigh 120-310 g. Average 160 g. Found in all habitats. Nest in trees, roofs or burrows. Swim up to 650 m	Three colour morphs (black/grey, brown with grey belly, and brown with cream/white belly). Tail longer than body length Large ears that cover eyes when folded forward	Contribute to the decline of endemic species globally. Target food stores, vegetation and crops as additional food sources. Damage human infrastructure.	Omnivorous and feed on plants and vegetation, invertebrates, mammals and birds.

Ship rats have well-developed senses of touch, smell, hearing and vision, and are mainly active at night. They are omnivorous and predate vertebrates as well as feed on human food waste (Shiels et al. 2014). Access to food can be restricted by the presence of predators and invasive species that compete for the same resources (Innes & Russell 2021).

They are skilled climbers (Foster et al. 2011) and inhabit tree canopies and roof spaces. Ship rats spend much of their time above ground (Hooker & Innes 1995), preferring not to burrow but will where forest habitat is absent (Pye et al. 1999).

Male ship rats have larger home ranges (0.1-1 ha) that overlap with one another, whereas females maintain smaller home ranges (0.08-0.7 ha) exclusive of one another (Hooker & Innes 1995).

Ship rats are a highly damaging and costly invasive species (Harper & Bunbury 2015, Cuthbert et al. 2022, Diagne et al. 2023) and are associated with the extinction of multiple species globally (Bell et al. 1978, Doherty et al. 2016).

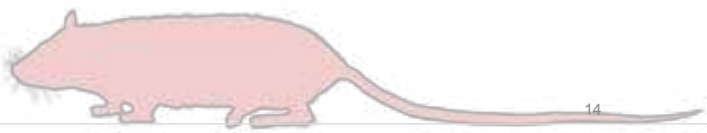
Ship rats were abundant on Ascension by 1701 (Duffey 1964). Despite earlier records stating that brown rats (*Rattus norvegicus*) were present on Ascension, there is no evidence to support this.

Since the removal of cats from Ascension Island (Ratcliffe et al. 2009), rat numbers have increased and are now the main predator of the island seabirds (Hughes et al. 2019), as well turtles and invertebrates (Ascension Island Government 2015a). The overall rat population on Ascension is not known; they occur in all habitats and likely have an island-wide distribution (Ascension Island Government 2015a).

Bell & Ashmole (1995) collected morphological data on Ascension's rat population before the feral cat eradication had been completed. Rats were trapped at Mars Bay, Palmers, and Elliot's Pass on Green Mountain. Adults weighed 126 g on average (n=46), with average head-body lengths of 159 mm (n=48). During this site visit, rats that had been trapped by the AIG within the last two months across Ascension were dissected, and morphological measurements were taken. Adults weighed 165 g on average (n=33), with average head-body lengths of 182 mm (n=33) (WMIL, unpublished data).

Ascension's unique history of terraforming Green Mountain may result in an introduced plant community that support populations of ship rats. Ship rats can occupy all habitats on tropical islands and rats will move between habitat types depending on local climate conditions and food availability (Harper & Bunbury 2015).

Examples of rat field sign are given in Appendix 3.



House Mice
Mus musculus

ABOUT	KEY FEATURES	IMPACTS	DIET
Live in a variety of habitats Have small home ranges Weigh ~20 g	Large ears for its size. Long, thin tail Small feet compared to juvenile rats Rounded body.	Impact most heavily upon invertebrates and vegetation, but also predate reptiles and birds.	Known to be omnivorous and opportunistic feeders and eat a range of food including invertebrates, plant material, lizards, birds and human products (Murphy & Nathan 2021).

House mice are small, 70-90 mm long, have long tails, large eyes, round ears and only weigh up to 25 g with no significant difference in size between males and females (Murphy & Nathan 2021). They are a dull brownish grey colour, with grey, brown or white belly (Murphy & Nathan 2021). Mice feet are uniformly grey on the top side, which can be used in combination with ear size and foot size to distinguish them from juvenile rats (Murphy & Nathan 2021).

Mice have acute hearing, smell and sight and this plays an important part in recognition (species and territory), food location, mate selection and predator avoidance (Lawrence & Brown 1974, Nowak 1999, Murphy & Nathan 2021). Mice are mainly nocturnal being most active around dawn and dusk, although they are often seen during the day, especially in summer (Murphy & Nathan 2021).

Mouse numbers fluctuate seasonally as they can be adversely affected by poor weather and habitat conditions. Generally, mice do not live longer than 18 months in the wild (Murphy & Nathan 2021). Mice can be found in a range of habitats from grassland to forest as well as houses, landfill sites, farm buildings and other human dwellings (Murphy & Nathan 2021). They have a very close association with people; and there are instances of mice dying out on isolated islands when people have left (Berry & Tricker 1969). Mice have been transported around the world in cargo, farm supplies and other goods (Murphy & Nathan 2021).

Mice have been implicated in the extinctions of invertebrates and a reduction in the regeneration of vegetation (Jones et al. 2003, Murphy & Nathan 2021). They can impact upon lizards, including species larger than themselves (Murphy & Nathan 2021). Mice have been shown to have an impact on seabirds as large as albatrosses (Davies et al. 2015).

Mice significantly impact upon biodiversity, with invertebrates being most greatly affected (Watts et al. 2022). It can be expected that mice will be impacting upon invertebrate species on Ascension. Additionally, mice are known to impact upon agriculture (Brown & Henry 2022) and can contribute to human health issues in urban settings (Williams et al. 2018). On islands where they occur as part of a suite of invasive mammals such as rats, the impact of mice are not as evident or as well documented, yet where mice are the only invasive species present, their impacts can be severe, particularly on ground-nesting birds including albatross (Angel et al. 2009, Connan et al. 2024).

It should be noted that if only rats are eradicated, house mice numbers are likely to increase rapidly as a result of a competitive release, which could undermine the gains achieved from the eradication of rats.

Examples of house mouse field sign are given in Appendix 4.

European Rabbits
Oryctolagus cuniculus

ABOUT	KEY FEATURES	IMPACTS	DIET
Associated with grassland and pasture areas Gather in communal burrows or warrens Native to the Iberian Peninsular, Europe.	Up to 40 cm head to tail length and can weigh up to 2 kg Long ears and hind feet Prone to population booms and crashes when living on islands without predators	Impact upon native flora by over- grazing Soil erosion and land slides occur in areas with high rabbit populations	Herbivores and can eat a range of plants. Often favour new shoots and leaves

The European rabbit is a small herbivore, usually grey-brown in colour, that is native to the Iberian Peninsula. Rabbits have been introduced to many parts of the world as both as food and source of fur. It is understood that rabbits were introduced to Ascension around 1820 from the Cape of Good Hope, and their numbers have fluctuated since this time (Duffey 1964, Bell & Boyle 2008).

Features of ideal rabbit habitat include rainfall <1000mm, light soil and adequate cover. They are closely associated with pasture grazed by livestock (Norbury & Duckworth 2021). Rabbits are a major vertebrate pest of agriculture, horticulture and forestry causing millions of pounds of damage per year worldwide (DEFRA 2004, Norbury & Duckworth 2021). In many countries the control of rabbits is a legal requirement for landowners or a government obligation to maintain the farming community (DEFRA 2004).

Impacts by rabbits on Ascension are predominantly on native plant species. They have affected the Ascension Island Conservation Department's efforts to establish new populations of Ascension spurge and purple fern (Ascension Island Government 2015b, Bell & Boyle 2008).

The 2008 rabbit eradication feasibility study (Bell & Boyle 2008) reported that Ascension "did not have a serious problem with rabbits", which was similarly the case from earlier accounts (Duffey 1964). Since the eradication of feral cats (Ratcliffe et al. 2009), rabbit numbers would likely have increased as a result of reduced predation pressure by feral cats.

During the site visit however, it was reported that rabbit numbers had dropped rapidly in the months prior, and only one live rabbit was seen during the site visit. This is in stark contrast to previous observations where rabbits were commonly observed in all habitats in both the day and night. It is suspected that a disease has been introduced, either accidentally or intentionally, that has heavily impacted upon the rabbit population. It is unlikely that this disease will remove all rabbits from Ascension, and it should be expected that their population numbers increase steadily again over time. It is recommended that rabbits are included as a target species for eradication, and that targeting them when numbers are low will increase the likelihood of success.

Common Myna
Acridotheres tristis

ABOUT	KEY FEATURES	IMPACTS	DIET
Closely associated with human habitation Gather in communal roosts, as well as roof voids Native to Asia	Black head and a brown body Striking yellow bill, legs and eye patches. Large white wing patches in flight.	Impact upon the breeding success of sooty terns. Competition with other land birds	Accomplished scavengers and opportunistic feeders, eating a range of food including invertebrates, plants and vegetables, as well as bird eggs and chicks.

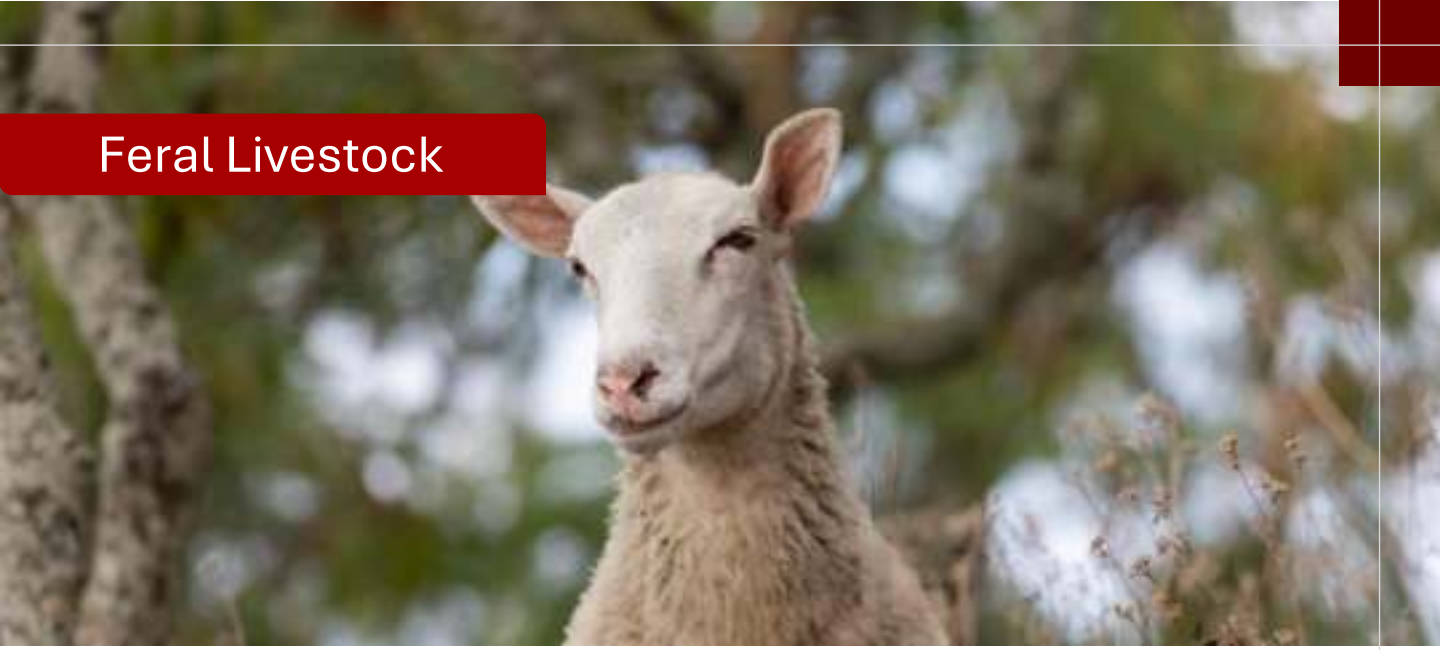
Common mynas are large, black-and-brown birds of the Sturnid family. They have white wing patches, yellow bill, and yellow legs. They are gregarious and often found in noisy flocks. They can be aggressive when defending their territory, often driving away other birds. Myna can be found just about anywhere but the densest forests. They are native to the Indian subcontinent, where it is among the most common species. They have been widely introduced around the world, often to control agricultural pest invertebrates, and are considered one of the worlds 100 worst invasive species (Lowe et al. 2000) and have been shown to cause population declines in native bird species (Grarock et al. 2012).

Full scale myna eradications are yet to be proven on islands over 3000 ha in size, with most eradication projects described involving trapping or shooting (Saavedra and Reynolds 2019). That said, their eradication has still been shown to be successful on small islands (Canning 2011, Feare et al. 2021, Millet et al. 2004). Ascension has trialed the use of Starlicide® to control mynas though there may still be issues with palatability at low toxin concentrations (Feare 2010).

Common mynas were first introduced to Ascension in 1879 (Duffey 1964). Continuous introductions of mynas were made over the following years and as a result a breeding population soon established and became common around areas of human habitation by 1958 (Duffey 1964). On Ascension myna impact sooty terns through egg predation, though they have been recorded predating other seabird species elsewhere that are found on Ascension (Feare et al. 2015). Myna predate an estimated 26,000 (13%) sooty tern eggs each breeding season (Hughes et al., 2019), and can predate roughly 3 times more tern eggs than ship rats (Hughes et al. 2008). Myna, along with black rats, are suggested to be preventing the population of sooty terns from increasing (Hughes et al. 2019).

Additionally, common mynas can impact upon human health and wellbeing. They are generally closely associated with human habitation, nesting in roof spaces which can bring lice and dust into properties leading to the development of respiratory infections in the occupants, and the potential transmission of *Salmonella* to residents of Ascension has been described (Allen 2009).

Feral Livestock



ABOUT	KEY FEATURES	IMPACTS	DIET
Feral sheep and donkeys were originally brought to Ascension as foot and transport. Donkeys are a desert loving species and prefer dry grassland habitats	Instantly recognizable species. Donkeys are a drought-resistant desert loving species and prefer dry grassland habitats. Sheep have a fleecy coat and are a common food species.	Both feral sheep and donkeys aid the spread of invasive plant species. Impact on human settlements by browsing gardens and obstructing traffic	Both donkeys and sheep are herbivorous. In cases where food availability is low, they will turn to feeding on refuge at the landfill.

Ascension is home to feral populations of sheep and donkeys. Donkeys were brought as a means of transporting both people and cargo as well as a source of food, and sheep were reared for farming (Duffey 1964). Both feral sheep and donkeys impact on the biodiversity of Ascension by grazing vegetation but can also present a risk to ground nesting birds through trampling, and damage community areas including contamination with animal waste.

Feral livestock graze on pasture, grass species and weed species such as Mexican thorn (*Neltuma juliflora*) and will actively spread invasive species and limit the distribution of native or endemic plant species (Walter & Levin 2008). They are known to feed on the seed pods of Mexican thorn (Lambdon & Darlow 2008) which helps this highly invasive plant to proliferate. Rat populations are known to be higher where there is Mexican thorn, using it as a source of food and shelter (Ascension Island Government 2015b), which highlights the potential for feral livestock to contribute to increased rat numbers across Ascension.

During any operation that attempts to eradicate invasive rodents, rabbits or myna, feral livestock will be at risk of consuming rodenticide unless they are eradicated beforehand or captured and contained within a corral. Livestock are known to interfere with bait stations and will directly consume bait placed openly on the ground.

It is recommended that if livestock are not to be targeted for eradication or control, that they are captured and managed within a corral during any operation that sets out to eradicate rodents, rabbits or myna. A decision would need to be made about whether they would be released post-eradication or kept in a management site. It is recommended that they would be kept in a management site, or at least sterilized before being released again to improve long-term control of their populations.

At present, the health of the feral donkeys is poor. They heavily supplement their diet by feeding at the landfill, consuming human rubbish such as cardboard, plastic, and human food waste. Several donkeys were observed to have injuries to their lower legs resulting from sharp metals and tins that are discarded at the landfill.

Feral sheep were observed largely around Two Boats Village, Travelers Hill and Green Mountain. Discussions with community members highlighted that communities in these areas feel the impacts of sheep disproportionately and have a greater desire to see sheep removed. Impacts include damage to private property caused by grazing and health concerns arising from animal droppings. Additionally, sheep will be impacting upon the native plant species that are found in this area, as well as encouraging the spread of invasive weed species.

FEASIBILITY

This section discusses the various aspects relating to feasibility and assesses the project against each of the seven key feasibility criteria. These assessments consider the challenges faced by a multi-species eradication on Ascension. As our collective knowledge and understanding of predator control is updated with new learnings and technology, this feasibility assessment should be reviewed and updated as well.

Overview

THE SITE ASSESSMENT

REVIEW OF CURRENT CONTROL

NON-TARGETS

THE 7 CRITERIA

THE OPTIONS

SPECIES ASSESSMENTS

Image:

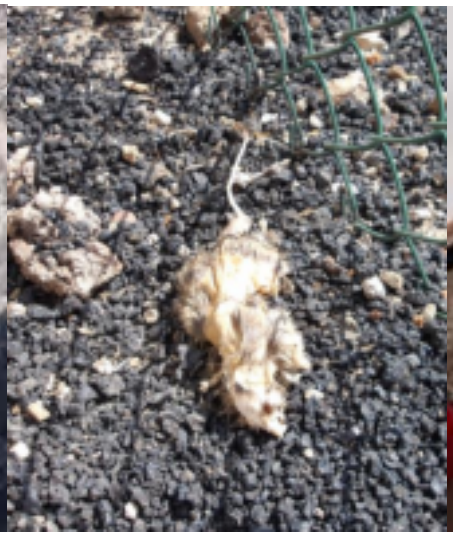
Site Assessment

A site assessment was conducted by WMIL between 21 January 2024 and 2 February 2024. During these two weeks WMIL met with local stakeholders, staff and community members to identify issues and concerns about the ongoing presence of invasive vertebrate pest species on Ascension and the proposed eradication and control of these species.

The objective of this visit was to assess the feasibility of eradicating mice, rats, rabbits, and mynas, as well as assessing the long-term control of feral donkeys and sheep, and to investigate the requirements of any such eradication or control operation. This includes assessing the suitability of techniques for the island and its community, difficulties expected to impact any operation, bait and trap types, operational requirements, and non-target impacts. Surveys of the island were conducted to assess topography, habitats and structures that may impact on any proposed eradication or control efforts.

Discussion with community members and project stakeholders showed that currently rats and mice are of greatest concern, and because of this they will be given greatest consideration in this eradication feasibility report. Alternatives to eradication were also investigated.

Both the rat and mice populations on Ascension were high during the site visit, with many seen including during daylight hours. It is believed this influx coincides with an unusually high rainfall in the months prior to this visit which has resulted in an abundance of seeds and fruits, leading to an increased rodent population. However, night surveys conducted at the landfill site showed that exceptionally high rodent populations are being sustained by current waste management practices. Rats caught by the Environmental Health team were dissected, with morphometrics and other findings recorded. A summary of these findings is provided in Appendix 6.



Key vegetation types identified that could pose challenges to an eradication operation include Mexican thorn and guava (*Psidium guajava*), as these are key food and harborage plant species for both rats and mice. Volcanic cave systems on Ascension would require additional baiting considerations, as aerial baiting would not provide effective coverage in this habitats. Rats and mice are expected to be present here.

Key non-target species are humans (particularly children), pet dogs and cats, feral sheep, feral donkeys, reptiles, marine life, seabirds and land birds (excluding common myna). Risks posed to these non-target species during an eradication must be sufficiently mitigated for. In addition to risks posed by the tools of eradication (toxins and/or traps), assessment of the Mars Bay Nature Reserve and Letterbox Nature Reserve has highlighted the potential risk that birds pose to drones and possibly helicopter operations. A summary of non-target species is provided in Appendix 7.

The presence of two military bases and high frequency radio sites will impose constraints on the extent of any aerial baiting operation, and it is therefore expected that any eradication operation on Ascension would require a significant ground-based element for success.

Review of Current Control

WMIL worked closely with the AIG's Environmental Health (EH) team during the site visit and spent time shadowing their team during bait station checks to assess current methodology. The EH team are currently responsible not only for rodent control, but also water quality testing, cleaning the Two Boats swimming pool, invertebrate pest control, collection of carcasses reported by the public in both public spaces as well as inside homes, and other tasks.

The control of rodents by EH covers all residential areas (Georgetown and Two Boats), several of the agency buildings and operational areas, public walking tracks around Green Mountain, and all the roads.

The areas where the EH team don't have responsibility are the US military base and UK military grounds, the hydroponics growing house, and the administrator's residence. These areas are maintained by relevant AIG staff, local agencies (MITIE – a UK facilities management company) or military personnel (i.e., Wildlife Officers). In some areas outside EH coverage, evidence of unethical drop traps were observed to be in place, resulting in prolonged death of caught mice by starvation and/or heat exhaustion. In these situations, AIG advised the relevant agencies that these traps were unethical and asked for them to be removed or replaced. Different bait formulations and toxin are used by each agency, with MITIE using a grain formulation with the active ingredient difenacoum.

Currently, the EH team are using four different second-generation anticoagulant rodenticides (SGAR): bromadiolone, brodifacoum, flocoumafen, difenacoum. All of which are in a wax block formulation.

Both brodifacoum and flocoumafen are highly toxic SGAR and are best reserved as a one-off eradication tool or last resort toxin if initial efforts fail to control or eradicate surviving individuals. WMIL would not recommend the use of these two toxins for ongoing long-term control.

The other two SGAR, bromadiolone and difenacoum, are best best used in pulsed control operations rather than on a permanent baiting regime. Bait should be deployed on a 3-monthly regime or before the breeding seasons of key species begin.

Figure 2 provides an example of the current baiting strategy undertaken by EH, though current coverage is higher than that shown here (as traps placed in houses in settlements, along English Bay Road, and at Comfortless and Ashpit areas and campgrounds or at Mars Bay are not shown). All main roads have bait stations spaced at regular intervals along them.

The workload of the EH team means consistent effort across all areas on the island cannot be maintained. Often large areas do not have ongoing rodent control and are only treated when complaints are raised by the community or prior to key public events or seabird or turtle breeding seasons.

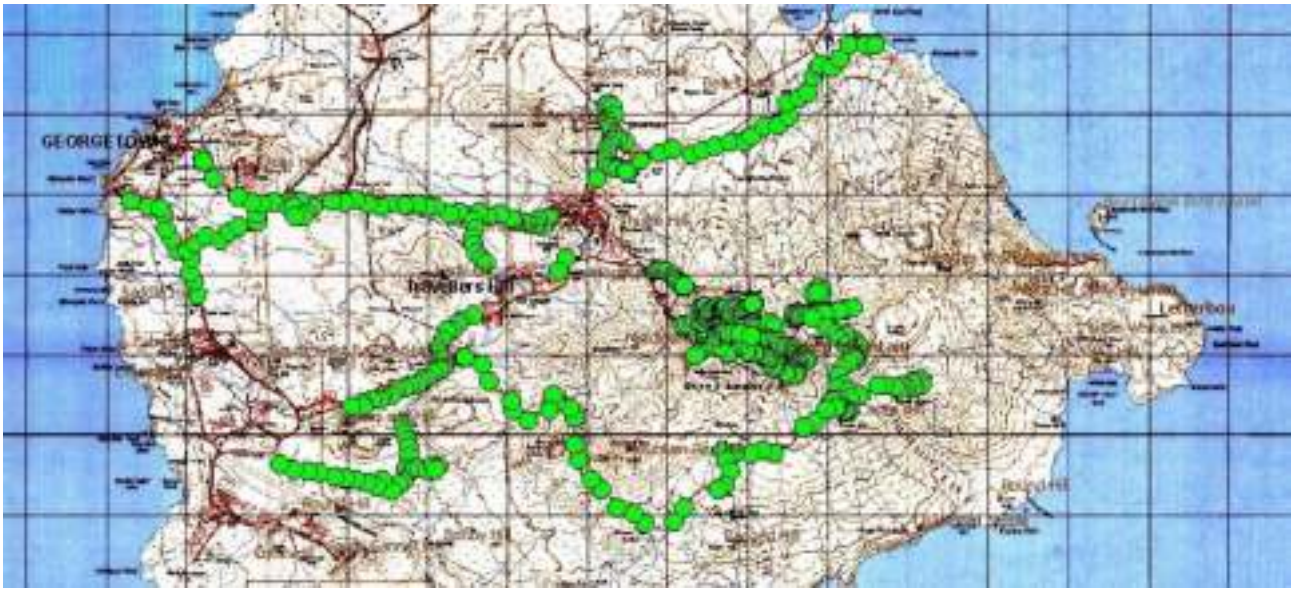


Figure 2 *An example of the current bait station network that is established along the roads and around Green Mountain on Ascension Island.*

Review of Current Control

Although the EH team are doing a significant amount of good work on rodent control, and rapidly respond to public requests for site-specific targeting of rats, much of their methodology does not follow best practice. Issues identified include:

1. **Multiple types of bait placed in the same bait station.**
This could result in rats and mice being deterred from one or more types of bait. It can also allow cross contamination of bait.

2. **Old bait was not fully removed if in bad condition. New bait is placed on top.**
This results in mouldy bait contaminating the new bait. Mouldy bait can reduce the attractiveness of the bait to rats and mice. This would reduce the efficacy of the control programme.

3. **Small amounts of old bait were tipped outside of the bait station and covered.**
All waste bait should be removed from the bait stations and disposed of either by incineration or burial at the landfill. Waste bait should not be available to any other species such as invertebrates and land birds. Any consumption of waste bait by these species increases the risk of secondary poisoning.

4. **No waste bait container was carried with the staff member while checking bait stations.**
All waste bait should be disposed of by either incineration or burial at the landfill. Waste collection buckets or bags should be carried by EH personnel.

5. **Where take was evident in small quantities, this was not recorded as such. A simplified 'No Take', 'Some Take', 'Full Take' data collection was used. This will make it impossible to quantify how much bait is placed into the environment.**
Accurate bait take records are vital. This provides an understanding of risk, environmental impact and numbers of rodents targeted. Data collection is currently done in notebooks or paper spreadsheets. This could be streamlined by using a bespoke offline phone app to allow in the field data collection, and rapid upload into the EH online data system when back at the office.

6. **Numbers of bait blocks used in each station varied.**
It is critical that the number of bait blocks are consistent between bait stations in each area. This allows EH to know how much bait is needed across the island, amounts of bait to take into the field when assigned a section of work, enable consistent annual bait orders, and ensures an accurate understanding of bait consumed by rodents.

7. **Bait not wired into stations.**
Bait is currently placed loose in the stations. This enables rodents and other non-target species such as crabs to remove the bait. This increases the risk to non-target species such as land birds, pet dogs, and feral stock. It is important that the bait is wired into the stations in a long-term control operation for non-target species safety and accurate measurements of bait used.

8. **Bait station positioning could be improved, and the use of GPS systems would improve efficiency of servicing.**
The location of all bait stations should be accurately recorded using GPS. This allows all bait take to be linked to location which will ensure patterns of rodent activity to be monitored over time.

9. **Bait stations were not secured down (either with stakes/rods, or with rocks).**
All bait stations should be secured using wooden or metal stakes. This will prevent accidental loss of bait due to wind or stock interference. It will also ensure the EH team can quickly find and service the stations. Bait stations need to be level and easily accessible to rats.

It is important that the rodent control undertaken on Ascension is improved and follows international best practice.

WMIL recommends that an intensive control programme is implemented covering key public areas on Ascension. Updated training for the EH team is also recommended. Detailed recommendations for ongoing rodent control on Ascension are given on page 42.

The 7 Criteria

For an eradication to be feasible it must meet all seven of the feasibility criteria. Failing to meet any one of them risks the success of the project. More detail on each criteria can be found in Appendix 8.

Technical Feasibility

- Can the technique(s) be used at the project site to remove all individuals of the target populations?

Sustainability

- Can the re-establishment of the pests be prevented?

Political & Legal Acceptability

- Can all required permits and consents be secured?

Social Acceptability

- Does the project have full support from the community?

Environmental Acceptability

- Can the impacts on the environment be managed or minimized?

Capacity

- Can the required skilled people, resources and equipment be found and acquired?

Affordability

- Can it be demonstrated to funders that the benefits of the project outweigh the costs?

The Options

In order to be considered feasible, an eradication project must expose every individual pest animal, of all species targeted, to the chosen eradication methods. The decision of which methods are to be used is informed by characteristics of the project such as target species, project area size, whether the area is inhabited or uninhabited, and what non-target species may be put at risk by the proposed method.

Different options are evaluated below (Table 1), and we conclude that a combined aerial and ground-based approach using bait stations and hand-broadcast, is feasible for the eradication of ship rats and rabbits from Ascension Island.

A summary of bait options are given in Appendix 9.

Table 1. *A breakdown of options available for the eradication and control of invasive species on Ascension Island and their expected outcomes.*

OPTION	OUTCOME	
DO NOTHING	Ascension will continue to host a range of invasive species. There will be continued loss of native species biodiversity and abundance, and the impacts on infrastructure and wellbeing will continue.	UNACCEPTABLE
CONTINUE RODENT CURRENT CONTROL	The workload for the EH team will continue to be stretched, and the effectiveness of their rodent control will remain limited. Recovery of biodiversity is unlikely, and the impacts on infrastructure and wellbeing will continue. Currently myna, rabbit and feral livestock are not controlled.	IMPRACTICAL (ineffective for biodiversity gains)
GROUND-BASED-ONLY ERADICATION	An island-wide eradication using ground-based methods for the eradication of house mice, ship rats and rabbits is unfeasible. For common myna and feral livestock however, ground-based eradication would be practical. Alternatively intensive ground-based control of mynas and feral livestock is also practical.	IMPRACTICAL (for mice, rat, rabbit) PRACTICAL (for myna and feral livestock).
AERIAL ERADICATION	Due to the presence of two military bases and other sensitive areas of infrastructure, there will be large areas of Ascension that cannot be targeted using aerial methods (i.e., helicopter).	IMPRACTICAL (due to no-fly areas)
COMBINED AERIAL AND GROUND-BASED ERADICATION	Due to the size of Ascension, helicopters (with additional drone support) are recommended to achieve the necessary coverage while reducing time and labour costs, while a ground-based approach will be required for no-fly areas. The eradication of ship rats and rabbits is feasible using these methods.	PRACTICAL (rats and rabbits only) (recommended)

As any eradication operation on Ascension is likely to be delayed until funding is available as well as needing a long lead-in time for planning requirements, a more focused control effort on highest priority areas will allow the EH team to achieve better results. Prioritising intensive control of rats and mice is recommended for greatest outcomes. This could be an effective strategy to implement in the short term, until sufficient funds can be obtained for full-scale island-wide eradication. See Page 42 for recommended intensive control strategy.

The Options

Continue current control

After spending time with the EH team on Ascension Island it is clear that their team size is too small to achieve effective results in terms of pest control in a bait station and trap network at key locations across the island and respond to reports of dead rats caught or recovered in properties, on roads, or walking tracks.

When seasonal changes result in higher rainfall, leading to increased vegetation growth and subsequent fruit and seed production (otherwise known as “mast” years), some sites on Ascension have suffered from mouse plagues and other agencies have taken control actions into their own hands via the use of home-made drop traps. These traps are unethical, and result in prolonged suffering to not only mice or rats that fall into them, but also non-target species including the protected land crabs or Sally Lightfoot crabs *Grapsus grapsus* (Figure 3).

Figure 3. *Drop traps made and used by other agencies to control plague numbers of mice have led to non-target mortality of protected species including Sally Lightfoot crabs (shown) and land crabs.*

The EH team don’t actively conduct any common myna control, unless they are reported as a nuisance in a property (i.e., nesting in roof spaces). No rabbit or feral sheep control is currently conducted.

The current workload for the EH staff is too great for a team of their size to effectively conduct pest control for biodiversity gains or to reduce rodent impacts on properties and people. Because of these, WMIL consider maintaining current pest control practices to be impractical and recommend an alternative strategy (see Page 42).

Conducting ground-based operations are labour-intensive, typically requiring large teams of people to help prepare and implement the strategy. This not only increases the cost of the project, but places pressure on local infrastructure to provide sufficient resources for large teams.

The Options

Ground-based eradication

Ground-based eradication methods have been used on large islands to eradicate rodents. These operations can use bait stations, hand-broadcasting of bait or a combination of methods. Langara Island (3100 ha) successfully eradicated brown rats using ground-based methods and remains one of the largest islands to do so (DIISE 2018, Taylor et al. 2000). Ground-based operations require significant labour levels and devices (if using bait stations), and often require an extended timeframe to deploy, and maintain bait availability to the target species. The presence of black rats and house mice on Ascension however make ground-based methods significantly more difficult due to smaller home ranges requiring a greater bait density across the island. Eradications using only ground-based methods are not yet proven for the eradication of these species from islands larger than 1350 ha in size (DIISE 2018, Bell 2109). Due to this, WMIL consider a ground-based eradication of invasive species on Ascension to be impractical.

The Options

Aerial eradication

Aerial-based eradications are often used (Russell & Broome 2016) and are considered best practice for large islands (Broome et al. 2014). Communities on islands where aerial operations may take place will require substantial consultation to understand the process, technical and operational requirements, and scale of such an operation.

Aerial-based eradications have been successful on large islands such as Campbell Island (11,300 ha; McClelland & Tyree 2002) and Macquarie Island (12,780 ha; Stringer 2016).

Aerial baiting operations use helicopters with GPS systems and specialised spreader buckets suspended underneath the helicopter. Helicopters follow GPS flight tracks and bait is spread across a known swathe underneath the helicopter. As a result, bait coverage can be determined with accuracy allowing for more efficient bait application.

Accurate measurements of an islands surface area are vital for eradication success, as is ground-based monitoring throughout to ensure that an aerial operation is succeeding. The team size requirements for ground-based monitoring are less than would otherwise be needed to conduct a ground-based-only eradication.

It is likely that any aerial aspect of an eradication would also use Unmanned Aerial Vehicle (UAV) or “drone” technology. This will be important to reach coastal zones and reduce the overall no-fly areas (due to helicopter requirements). Payload drones can be used to place bait as well as to monitor the target species. Drones should be used as part of any eradication operation on Ascension to help achieve these aims. An overview of drones is provided on Page 47.

The Options

A combined approach

While aerial operations are best practice for large islands, ground-based approaches are still used on islands with communities (Bell 2019) and can be combined with aerial methods (Harper et al. 2020, Lawrence et al. 2017) as shown by Lord Howe (see Case Study).

A combined aerial and ground-based operation should be used to tackle the invasive rats and rabbits present on Ascension, as they are susceptible to these methodologies and has been demonstrated to be effective on other large island eradication projects (Springer 2016).

Eradication of common myna could only be achieved by using an avicide combined with trapping and shooting. These methods are expected to be more confrontational to members of the island community, and the impacts of this on the community should be given great consideration.

The eradication of feral livestock will also only be achieved by a ground-based operation. This will also be confrontational to the island community, and consultation will be required to confirm the opinions of all residents. It is likely that there would be opposition to the eradication of feral donkeys given the historical and social connection. There may be less opposition to the eradication of feral sheep, and this is tied to where people are resident, but several people still hunt the sheep for food.

Due to the complexities identified on Ascension such as the presence of significant no-fly zones, human habitation, and key non-target species including internationally important breeding seabird colonies, **a combined approach is recommended for the eradication of ship rats and rabbits.**

The Species Assessments

A multi-species eradication program on Ascension would require the use of different methodologies adapting to the requirements of the invasive species targeted, the habitat, and the proximity to human habitation.

Invasive vertebrate species eradications have been conducted successfully on both inhabited and uninhabited islands of significant size, such as inhabited Lord Howe Island (population = 350, area = 1,445 ha; Harper et al. 2020) and uninhabited Campbell Island (11,300 ha; McClelland & Tyree 2002). A multi-species eradication targeting house mice, ship rats and European rabbits on Macquarie Island (12,870 ha) successfully eradicated these species (Springer 2016).

Operations such as these require meticulous planning and preparation (Springer 2011) and will require the support and understanding of the island community.

Each of the key target species that have been investigated for eradication are covered separately.

House Mice

Ship Rats

European Rabbits

Common Myna

Feral Donkeys

Feral Sheep

House Mouse Eradication

UNFEASIBLE

Currently, the extent of the ground-based requirement (covering the no-fly zones) for eradicating house mice makes the capacity and affordability requirements unfeasible at this time.

Criteria	Assessment	Outcome
Technically Feasible	House mice eradications have been shown to be possible on large islands using aerial baiting methods, as well as combined with ground-based methods. However, the scale of ground-based requirement on Ascension is large (593 ha), and it will depend on the ratio of aerial to ground-based requirements as to whether this is technically feasible.	**CONDITIONAL**
Sustainable	The sustainability of any eradication project relies on strict biosecurity protocols to prevent reinvasion of the target species after eradication has been achieved. On islands with communities this relies heavily on support to help achieve and maintain this. The eradication of house mice is considered sustainable on Ascension if support to implement the necessary biosecurity protocols is given by the community and agencies on island.	**CONDITIONAL**
Politically and Legally Acceptable	As Ascension is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The project has the support of local and national agencies on Ascension and would be one of several large-scale island eradications that have been attempted in the region.	**PASS**
Socially Acceptable	Initial discussions with community members and stakeholders showed support for the eradication of rodents from Ascension. Further consultation should cover pre-eradication requirements such as managing livestock and pets before an eradication attempt, to ensure that the island communities were supportive of any proposed methods.	**PASS**
Environmentally Acceptable	To successfully eradicate house mice from Ascension, bait would need to be applied aerially across the island as well as on the ground in no-fly zones. This increases risks to non-target species and the wider environment. These risks can be mitigated but will increase the timescale and associated costs for this aspect of the project.	**CONDITIONAL**
Capacity	A house mouse eradication on Ascension is estimated to require a minimum of 593 ha to be baited with ground-based methods due to no-fly zones. A minimum estimated 60,823 bait stations would be required to target house mice in these areas using a 10 m x 10 m bait grid, requiring an estimated 101 ground staff. There is not currently capacity on island to accommodate teams of this size.	**FAIL**
Affordability	The eradication of house mice from Ascension is expected to cost upwards of £45,000,000. This is separate from any other target species eradication, and the inclusion of other species would increase these costs owing to additional requirements associated with their removal.	**FAIL**

House Mouse Eradication

Technically Feasible

House mice will be challenging to successfully eradicate from Ascension and there is a higher likelihood of failure associated with their removal. With ground-based methods, mice typically require a 10 m x 10 m baiting grid, to cover all available habitats. To put this into context, to eradicate mice from Ascension using only ground-based methods, over 1 million bait stations would be required and a team in the region of 1,500 people. This of course makes a purely ground-based operation unfeasible, impractical, and is the reason that a mouse eradication should only be considered using aerial baiting techniques.

With an aerial operation, the bait loading requirements are significantly higher to ensure enough rodenticide is available to mice, especially in tropical regions where crabs will compete for bait. This will increase the bait requirements for the project. Mice have been successfully eradicated from other inhabited islands such as Lord Howe using a combination of aerial and ground-based methods (Harper et al. 2020). In a combined approach, aerial baiting is used to bait areas outside of all identified no-fly zones, while ground-based methods are used within them.

The technical feasibility of a mouse eradication depends on the extent to which no-fly zones will require ground-based methods. Data from the USSF has identified several no-fly zones requiring 200 m exclusion zones around them. In addition to this, WMIL identified all other areas of infrastructure (i.e., settlements, radio masts etc.) which would require inclusion into the no-fly zones and will require the use of ground-based methods to successfully mitigate risks to people and helicopters. There are also significant seabird colonies which may or may not require ground-based approaches to mitigate bird strikes and the associated risks to both birds and people. Additional input from helicopter pilots with specialist experience of aerial eradications on islands with seabirds should be consulted prior to any decision on enforcing no-fly zones around seabird colonies.

In a best-case scenario the assumption is that 200 m no-fly zones apply to areas identified by the USSF and, based on other aerial eradications on islands with resident communities (e.g., Lord Howe; Harper et al. 2020), all other infrastructure will have a no-fly zone up to 30 m from the property boundary. It has been assumed that all seabird colonies can be baited aerially. The total no-fly area is 593 ha and would require a 10 m x 10 m grid, totalling 60,823 bait points.

A worst-case scenario assumes that, in addition to the USSF no-fly zones, all other infrastructure will have no-fly zones enforced up to 150 m from the property boundary, and that all seabird colonies would also require ground-based methods, resulting in a total non-fly area of 1,558 ha requiring 155,829 bait points.

Eradications of mice across areas of this size have not yet been proven to be achievable using ground-based techniques (Mackay et al. 2007). The feasibility of this methodology is therefore dependent on the extent to which no-fly zones will impact the ground-based element of an eradication.

Additionally, waste management practices are currently limiting the feasibility of mice eradication due to abundant alternative food and harbourage sites being readily available. Communications with the Operations and Facilities Directorate highlight that improvements are being made to waste management procedures on Ascension, with long-term plans to reduce food waste at the landfill site to below 10% of levels 2 years previously.

Sustainable

The sustainability of a mouse eradication would rely heavily on the biosecurity protocols that are enforced. Due to Ascension's remote location, the only identified pathways of reintroduction are via cargo or with passengers arriving on the island by air or boat. WMIL consider these reintroduction pathways to be manageable, though depend on the support of multiple agencies. The sustainability of a mouse eradication is considered feasible, on the condition that all agencies commit to uphold strict biosecurity measures.

Due to the different agencies involved, ongoing discussions should focus on long-term improvements to biosecurity that will help systems establish that can detect and remove mice before they can establish beyond the biosecurity border. A strict quarantine procedure for freight and passenger luggage should be a high priority.

House Mouse Eradication

Politically and Legally Acceptable

As a UKOT, Ascension is expected to have the same political and legal backing in the UK that supports conservation projects seeking to restore native species biodiversity.

Discussion with community members during the site visit showed that there was significant local and national support for the eradication of rodents from Ascension.

Socially Acceptable

Conversations with residents and community members on Ascension showed that there is strong public support for the removal of house mice. Concerns about an eradication project focused largely on the risks to children associated with the presence of toxin on the ground. Mitigating this risk would rely on effective education and communications strategy, to highlight the danger of consuming baits found on the floor after any aerial drop. No opposition to an aerial baiting operation was communicated, and all community members spoken to were enthusiastic and supportive.

Environmentally Acceptable

The environmental impacts associated with an aerial baiting operation on Ascension are potentially high, and appropriate mitigation measures should be put in place.

Non-target species will be at risk of direct and secondary poisoning through consumption of bait pellets and rodent carcasses respectively. Feral livestock are at risk of poisoning through directly consuming bait pellets, and it is recommended that they are corralled prior to any eradication. Crabs will consume bait but are not affected by the toxins (Pain et al. 2000). Land birds such as yellow canary, common waxbill and red-necked francolin (*Pternistis afer*) are likely to feed on pellets that are found on the ground, as well as invertebrates that may contain toxin.

In addition to direct impacts resulting from the use of rodenticide on Ascension, indirect environmental impacts are also expected as a result of an aerial operation.

Helicopters are expected to be operational for 8 hours per day for two months, resulting in prolonged disturbance for the Ascension community. If helicopters are to aerially apply bait near or over seabird colony sites, an increased risk of bird strike should be expected.

The environmental impacts of an eradication are typically short term, and the medium to long-term gains of island eradications are expected to outweigh any losses that may result during the operation. Ascension already has a history of invasive species removal with toxins, with the eradication of feral cats (Ratcliffe et al. 2009) successfully leading to the recolonisation of the main island by Ascensions seabird species.

Capacity

There is an estimated 61,000 bait stations needed to cover the no-fly zones. Estimated team sizes assume that each staff member can service an average of 200 bait points per day, and that all bait points are checked every three to five days. A 3-day cycle is required to ensure that sufficient bait is available for mice to consume a lethal dose, as competition with rats and land crabs will reduce bait availability for mice and risks them not accessing a lethal dose.

Depending on the extent of no-fly zones and subsequent ground-based requirement, team size is expected to require at least 100 individuals. Accommodating teams of this size is a key limiting factor in the overall feasibility of a mouse eradication. Potential ways of accommodating large teams for an eradication project could include the use of a vessel moored offshore, with teams transported onto Ascension daily, as well as refurbishing buildings to provide accommodation on Ascension.

Affordability

It is estimated to cost £45,000,000 to successfully eradicate house mice from Ascension, which is currently beyond any funding capabilities of the AIG or partner agencies.

Ship Rat Eradication

FEASIBLE

(DEPENDENT ON CONDITIONS DETAILED BELOW)

Criteria	Assessment	Outcome
Technically Feasible	Ship rat eradications have been shown to be possible on large islands using aerial baiting methods, as well as combined with ground-based methods. Although the scale of ground-based requirement on Ascension would be large, it is considered technically feasible.	**PASS**
Sustainable	The sustainability of any eradication project relies on strict biosecurity protocols to prevent reinvasion of the target species after eradication has been achieved. On islands with communities this relies heavily on support to help achieve and maintain this. The eradication of ship rats is considered sustainable on Ascension if support to implement the necessary biosecurity protocols is given by the community and agencies on island.	**CONDITIONAL**
Politically and Legally Acceptable	As Ascension is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The project has the support of local and national agencies on Ascension and would be one of several large-scale island eradications that have been attempted in the region.	**PASS**
Socially Acceptable	Initial discussions with community members and stakeholders showed support for the eradication of ship rats from Ascension. Further consultation should cover pre-eradication requirements such as managing livestock and pets before an eradication attempt, to ensure that the island communities were supportive of any proposed methods.	**PASS**
Environmentally Acceptable	To successfully eradicate ship rats from Ascension, bait would need to be applied aerially across the island as well as on the ground in no-fly zones. This increases risks to non-target species and the wider environment. These risks can be mitigated but will increase the timescale and associated costs for this aspect of the project.	**CONDITIONAL**
Capacity	A ship rat eradication on Ascension would require a minimum estimate of 593 ha to use ground-based methods due to no-fly zones limiting aerial application. A minimum estimate of 9,720 bait stations would be required to target ship rats in these areas, requiring an estimated 35 ground staff. There are some options that could be suitable to accommodate a team of this size, though would need confirming.	**CONDITIONAL**
Affordability	The eradication of ship rats from Ascension is expected to cost in the region of £33,000,000. This is separate from any other target species eradication, and the inclusion of other species would increase these costs owing to additional requirements associated with their removal.	**CONDITIONAL**

Ship Rat Eradication

Technically Feasible

As with house mice, a purely ground-based operation is unfeasible and impractical due to the immense resource and capacity requirements of such an operation when implementing a 25 m x 25 m grid for ship rats (160,000 bait stations and roughly 500 people). Therefore, relying solely on a ground-based operation is unfeasible and impractical. Ship rats therefore, like house mice, can only be eradicated using aerial baiting as the primary baiting methodology, with ground-based methods targeting areas restricted by no-fly zones.

A best-case scenario of 592 ha requiring a 25 m x 25 m grid, would require a total of 9,455 bait points, and an estimated team size of 32 staff. A worst-case scenario assumes that 1,558 ha would require a 25 m x 25 m grid, totalling 24,839 bait points and an estimated team size of 83 staff.

Successful ground-based ship rat eradications have taken place on islands up to 444 ha in size (DIISE 2018). Eradicating ship rats from Ascension is considered technical feasible if the ground-based aspect can be kept below this area. Over this area, it is expected to become increasingly difficult due to increased team size requirements and associated costs.

Though many large-scale ground-based eradications have been underway on the North and South Islands of New Zealand as part of the Predator Free by 2050 ambition, these have not yet been proven to be successful at this scale. Where resident communities occur, challenges arising from waste management and microhabitats result in a higher chance of eradication failure. An option that may be more practical on Ascension would be to implement an alternative control strategy which could also result in conservation gains. It should be noted that these gains would only be achieved for as long as improved control can be sustained.

Sustainable

The sustainability of a ship rat eradication, much like a house mouse eradication, would rely heavily on the biosecurity procedures that are enforced on island. Due to the different agencies involved, ongoing discussions should focus on long-term improvements to biosecurity. A quarantine procedure for freight and passenger luggage should be a high priority if an eradication project were to occur. The feasibility of sustaining an eradication is considered feasible, on the condition that all agencies involved commit to uphold strict biosecurity measures.

Politically and Legally Acceptable

As a UKOT, Ascension is expected to have the same political and legal backing in the UK that supports conservation projects seeking to restore native species biodiversity.

Socially Acceptable

Conversations with residents and community members on Ascension showed that there is strong public support for the removal of ship rats. Concerns about an eradication project focused largely on the risks to children associated with the presence of toxin on the ground. Mitigating this risk would rely on effective education and communications strategy, to highlight the danger of consuming baits found on the floor after any aerial drop. No opposition to an aerial baiting operation was communicated, and all community members spoken to were enthusiastic and supportive.

Environmentally Acceptable

The environmental impact associated with the bait application for ship rats is expected to be similar to that for house mice. Though ship rat populations are less dense than house mice, a high bait application is expected to be necessary to ensure that all individuals of the ship rat population have access to sufficient bait to consume a lethal dose. The presence of mice and crabs will mean there is a high level of competition for bait. The lack of options for excluding mice and crabs from the bait will mean that higher bait loadings will be required to compensate for this.

The risks to non-targets will therefore be like those described for a house mouse eradication. Other risks, such as disturbance and bird strike, will also be similar as the method of bait application are expected to be the same.

Ship Rat Eradication

Capacity

There is an estimated 10,000 bait stations needed to cover the no-fly zones. Estimated team sizes assume that each member of staff services an average of 100 bait points per day, and that all bait points are checked every three to five days. Note that a 3-day servicing regime for the ground-based bait points should be used for ship rats to ensure that bait availability is high enough for individuals to consume a lethal dose, due to competition for bait that will result from the presence of crabs and mice.

The feasibility of sufficiently resourcing a ship rat eradication team relies on the extent of the ground-based area, as determined by the no-fly zones. If the smaller ground-based area using a 30 m buffer around infrastructure (593 ha) can be used, a team of 35 staff is considered feasible. A larger area (1,558 ha) resulting from a 150 m buffer around infrastructure would result in a team requirement of 83 staff. This would become unfeasible for Ascension owing to a lack of accommodation options. Solutions to this could lie in the use of vessels to house the field team, or the refurbishment of buildings on Ascension to temporarily repurpose them for the project team.

Affordability

It is estimated to cost approximately £33,000,000 to successfully eradicate ship rats from Ascension, which is currently beyond any funding capabilities of the AIG or partner agencies. This project could proceed if philanthropic funding is obtained, or other alternative large funding bids are successful.

European Rabbit Eradication

FEASIBLE

(DEPENDENT ON CONDITIONS DETAILED BELOW)

Criteria	Assessment	Outcome
Technically Feasible	Rabbit eradications have been shown to be possible on large islands using aerial baiting methods, as well as combined with ground-based methods and use of biological agents. The scale of ground-based requirement on Ascension would be large, and its feasibility would be affected by the ratio of aerial and ground-based requirement. It is considered technically feasible, conditional on the extent of the ground-based requirement and approval to use toxic bait to target rabbits.	**CONDITIONAL**
Sustainable	The sustainability of any eradication project relies on strict biosecurity protocols to prevent reinvasion of the target species after eradication has been achieved. On islands with communities this relies heavily on support to help achieve and maintain this. The eradication of rabbits is considered sustainable on Ascension if support to implement the necessary biosecurity protocols is given by the community and agencies on island.	**PASS**
Politically and Legally Acceptable	As Ascension Island is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The project has the support of local and national agencies on Ascension Island and would be one of several large-scale island eradications that have been attempted in the region.	**PASS**
Socially Acceptable	Initial discussions with community members and stakeholders showed support for the eradication of rabbits from Ascension, but further widespread consultation should be completed to ensure this opinion is valid across the whole community. The choice of eradication methodology (e.g., disease) may also affect community support. Further consultation should cover pre-eradication requirements such as managing livestock and pets before an eradication attempt, to ensure that the island communities were supportive of any proposed methods.	**CONDITIONAL**
Environmentally Acceptable	To successfully eradicate rabbits from Ascension, bait would need to be applied aerially across the island, with the potential option of follow up trapping or hunting required. This increases risks to non-target species and the wider environment. These risks can be mitigated but will increase the timescale and associated costs for this aspect of the project.	**CONDITIONAL**
Capacity	A rabbit eradication on Ascension would require a minimum estimate of 593 ha to use ground-based methods due to no-fly zones limiting aerial application, and if done in conjunction with the rat eradication, a similar sized team (35 people) would be needed. If rabbits were targeted at the current low population size, a team of 15 people would be needed to hunt and successfully target the remaining population.	**CONDITIONAL**
Affordability	The eradication of European rabbits from Ascension Island is expected to cost in the region of £7,000,000. This is separate from any other target species eradication, and the inclusion of other species would increase these costs owing to additional requirements associated with their removal.	**CONDITIONAL**

Rabbit Eradication

Technically Feasible

Rabbit eradications have taken place on islands up to 12,865 ha in size by combining aerial and ground-based methods. Rabbits were successfully removed from Macquarie Island (see Case Study) in a multi-species eradication by first applying bait aerially, predominantly to target ship rats and house mice, and following this up with detection dogs and hunting to mop up remaining rabbits (Springer 2018).

It is illegal to lay poison baits for rabbits in the UK; however, this may not be relevant under Ascension law. Special dispensation would most likely be required. Baiting is one of the most cost effective and successful ways to eradicate rabbits from islands and controlling rabbits on mainland sites in many countries (Bell 2001, Bloomfield 1999, Courchamp et al. 2003, Devine & Cook 1998, Farrelly & Merks 2005, Torr 2002). In most cases, cereal-based pellet baits are used containing a variety of toxins, including brodifacoum, pindone, and sodium monofluoroacetate (1080). Owing to the concerns about persistence and impacts on non-target species, pindone is the recommended toxin for use on rabbits only. However, for a joint operation with rats, brodifacoum would be a better option.

During the 2024 site visit to Ascension, it was noted that the current rabbit population is very low, with only one live rabbit being observed for the duration of the visit (L. Titterton, WMIL, pers. obs.). Low rabbit numbers were further confirmed by reports from community members and the AIG, and observations of much greater vegetation growth in areas that were previously heavily grazed by rabbits. This is in stark contrast to previous feasibility studies that reported high numbers of rabbits (Bell et al. 2008). The cause of the rabbit population crash is currently unknown, though it is likely that a virus such as Rabbit Calicivirus Disease (RCD) or Rabbit Viral Haemorrhagic Disease (RVHD) has been introduced to the island and impacted the rabbit population.

Viruses are used as a bio-control agent in New Zealand and Australia, but their use in UKOT is not permitted. Lab testing of rabbit carcasses on Ascension may confirm if a virus has been the cause of this population decline, and whether the virus is still present in the remaining population. Understanding the cause of this population crash is the recommended first step in preparing for rabbit control or eradication on Ascension.

If a virus has become introduced into the rabbit population on Ascension, it should be expected that their numbers will fluctuate over time. A rabbit eradication should be timed to take place when their population numbers are low, to minimise the overall cost of eradicating them as was done on Macquarie Island (Springer 2016). If numbers are sufficiently low, it is expected that a rabbit eradication could be achieved using minimal amounts of toxin, and primarily a combination of hunting, trapping and detection dogs on Ascension. As these methods have been used to “mop-up” depleted populations of rabbits from other large islands, these methods are considered feasible for Ascension.

If there is not a virus present within the rabbit population, numbers should be expected to increase over time, and likely return to a level higher than that seen in the 2008 feasibility study (Bell et al. 2008) due to the abundance of vegetation that is available on island. If this were to happen, a rabbit eradication would require both aerial and ground-based methods. In this instance, a rabbit eradication should be combined with any rodent eradication as the recommended methods will be able to target both rodents and rabbits. It would be impractical to exclude rabbits from an aerial eradication targeting rodents due to the risk from consuming bait and requirements to managing the rabbit population during and following the rodent eradication. Including rabbits in a rodent eradication would lead to considerable cost savings.

Sustainable

As discussed in both rodent assessments, the sustainability of any invasive species eradication would depend on the biosecurity protocols put in place by the multiple agencies who operate on Ascension Island. Each agency would have to strictly abide by the biosecurity protocols. Priority would be placed on quarantining incoming freight and passengers to ensure that invasive species do no re-establish.

Politically and Legally Acceptable

As a UKOT, Ascension Island is expected to have the same political and legal backing in the UK that supports conservation projects seeking to restore native species biodiversity.

Rabbit Eradication

Socially Acceptable

The 2008 feasibility study reports that "*...the eradication of rabbits from Ascension Island is not desired at present, and most locals would not support any rabbit eradication...*". Community consultation should be undertaken again prior to any rabbit eradication, as public opinion may have changed because of reduced impacts on plants associated with the reduced rabbit population.

Environmentally Feasible

For high rabbit populations, it is recommended that they are targeted in conjunction with a rodent eradication using aerial methods. The environmental impacts associated with this strategy have been described previously.

If rabbit populations are low prior to an eradication attempt they could be targeted separately from rodents using hunting, trapping, and detection dogs. The environmental impact of such an operation is expected to be low and restricted largely to disturbance resulting from hunters working in the environment. Risks to non-targets would be present, though mitigated largely through ensuring that a highly skilled and experience team of hunters are chosen for a rabbit eradication using these methods.

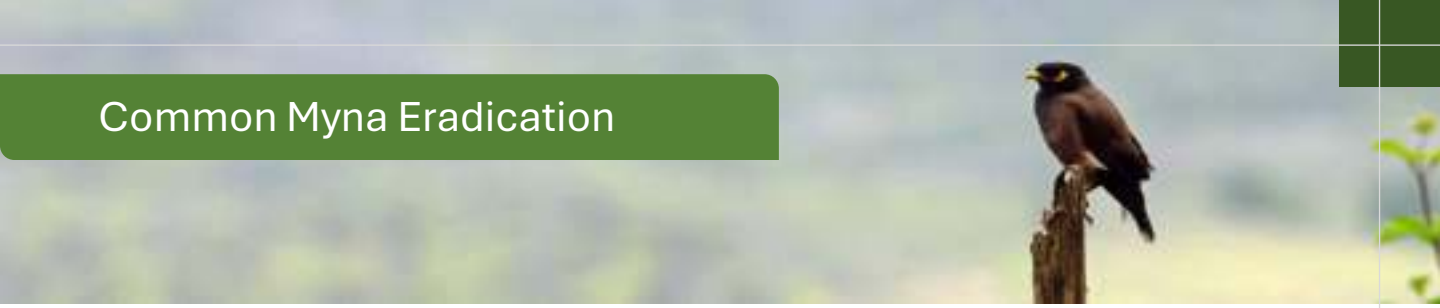
Capacity

If rabbits are targeted at low populations such as those observed during the site visit, it is expected that a team of 15 people would be able to methodically search for and remove rabbits from the areas of Ascension they remain.

The team requirement would increase if the rabbit population recovers, and if targeted in conjunction with rodents in a more intensive eradication effort, team sizes would reflect those given for the rodent eradications discussed previously.

Affordability

It is estimated to cost £7,000,000 to successfully eradicate rabbits from Ascension, which is currently beyond any funding capabilities of the AIG or partner agencies.



Common Myna Eradication

FEASIBLE

(DEPENDENT ON CONDITIONS DETAILED BELOW)

Criteria	Assessment	Outcome
Technically Feasible	Common myna eradications have not been shown to be successful on islands up to 2,693 ha in size, and large populations (>20,000 individuals) of myna have been successfully eradicated. The estimated population of myna on Ascension is 1,150 birds which could be targeted for eradication, though trials to determine a suitable method (i.e., avicide, traps, hunting, etc.) would be needed.	**CONDITIONAL**
Sustainable	The sustainability of any eradication project relies on strict biosecurity protocols to prevent reinvasion of the target species after eradication has been achieved. On islands with communities this relies heavily on support to help achieve and maintain this. The eradication of common myna is considered sustainable on Ascension if support to implement the necessary biosecurity protocols is given by the community and agencies on island.	**PASS**
Politically and Legally Acceptable	As Ascension is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The project has the support of local and national agencies on Ascension and would be one of several large-scale island eradications that have been attempted in the region.	**PASS**
Socially Acceptable	Further consultation would be required to better ascertain what public support there is for the complete eradication of myna from Ascension. As there is significant support for the removal of rodents, who impact upon the daily lives of community members, there could also be similar levels of support for the removal of myna as these birds can be of public nuisance and pose risks to human health and safety.	**CONDITIONAL**
Environmentally Acceptable	To successfully eradicate myna from Ascension, toxic bait would first need to be applied at key myna feeding sites such as the landfill. This would pose risk to non-target species and would require appropriate mitigation. This would then be followed up with trapping and shooting, which is expected to be less impactful on the environment.	**CONDITIONAL**
Capacity	A myna eradication on Ascension would require a minimum estimated team size of 12 people to successfully eradicate myna in an efficient and coordinated approach.	**PASS**
Affordability	The eradication of myna from Ascension is expected to cost in the region of £4,000,000 . This is separate from any other target species eradication, and the inclusion of other species would increase these costs owing to additional requirements associated with their removal.	**CONDITIONAL**

Common Myna Eradication

Technically Feasible

Common myna eradications have taken place on several islands around the world (DIISE 2018). The largest whole-island eradication that has successfully removed myna is Atiu Island (2,947 ha; Cruz and Reynolds 2019). As opposed to a rabbit eradication that could be run concurrently with a rodent eradication, targeting myna simultaneously to other invasive species on Ascension (i.e. rodents or rabbits) would not be possible with the same methods, and so a different strategy would be required.

Successful eradications of myna typically involve a combination of trapping, shooting and avicides. No myna eradication has been done purely using avicides, nor are avicides considered feasible to eradicate myna from Ascension. Starlicide® was trialled for myna control on Ascension, but bait aversion was apparent even at low concentrations, with mortality rates observed to decrease after one day of baiting (Feare 2010). For this reason, trapping and shooting, with avicide potentially used in combination with these methods, would be necessary to make a myna eradication on Ascension feasible.

During the site visit, it was apparent that although myna were most abundant around human settlements and the landfill site, they were also present in areas away from human habitation, which supports findings of Hughes et al. (2017) who reported that myna were observed in 85% of 1 km grid squares across the island. Further data presented by Hughes et al. (2017) suggest that the myna population on Ascension was an estimated 922 birds (9.5 birds/km^2) and was increasing at a rate of 1.75% per year. Assuming no external factors have altered the population growth rate since this study, the current population of common myna is estimated to be 1,150 birds.

For comparison, the eradication of 1,186 myna from Denis Island, Seychelles (140 ha) was undertaken using trapping and shooting (Feare et al. 2017). It was implemented in three phases and lasted five years (Feare et al. 2017). Reasons for this prolonged timeline may have related to limitations around the methods that could be applied, due to non-target risk and unfavourable myna behaviour (no dense flocking behaviour) (Feare et al. 2017). The use of an avicide on Ascension could potentially shorten this eradication timescale but would still require significant input from skilled hunters and trappers to remove every individual. Due to the large aggregations of myna at the landfill site, as with previous control efforts, this would be likely where most control methods would be used.

The eradication of myna on Ascension is considered feasible, though would require a combination of methods.

Sustainable

As with the previously discussed rodent and rabbit eradication feasibilities, the sustainability of any invasive species eradication would depend on the biosecurity protocols put in place by the multiple agencies who operate on Ascension Island. Each agency would have to strictly abide by the biosecurity protocols. Priority would be placed on quarantining incoming freight and passengers to ensure that invasive species do no re-establish.

The risk associated with the reintroduction of common myna on Ascension after an eradication is not considered high, and sustaining a successful eradication is considered feasible with strict biosecurity protocols.

Politically and Legally Acceptable

As a UKOT, Ascension is expected to have the same political and legal backing in the UK that supports conservation projects seeking to restore native species biodiversity.

Socially Acceptable

The use of avicides can be controversial owing to the visual impact on resident communities caused by birds dying at roost sites, as well as individuals that may die on route to their roost site and fall to the ground in public spaces. If avicides were to be used on a larger scale to aid the removal of myna from Ascension, further public consultation would be required and the feasibility of this would depend on community support for these methods.

Common Myna Eradication

Environmentally Feasible

As a myna eradication would require the use of toxins for at least part of the operation, risks to the environment would be present, although they would apply to a much smaller area and for a much shorter timeframe. As with rodent or rabbit eradications, impacts on non-target species would be the main risk. Methods of excluding non-target species from bait would require novel feeding station designs but would be unlikely to exclude small bird species such as yellow canary and common waxbill.

Once baiting has been used to initially reduce the population, trapping and hunting should be used to target remaining individuals. The environmental impacts associated with these methods are much less than those for baiting, and primarily arise from disturbance caused by trappers and hunters working across the island.

Capacity

It is expected that a team of 12 people would be able to first bait myna at identified feeding and roost sites, followed up by trapping and hunting to target the remaining individuals over a six-month period.

This team size is expected to be feasible to accommodate and resource while staying on Ascension. Because myna are present over much of the islands land area, this size of team is required to be able to cover all potential habitats where myna may occur.

Affordability

It is estimated to cost £4,000,000 to successfully eradicate myna from Ascension. This is considered obtainable but will still need to be funded by external grants or funding bodies, as this will be outside the current budgets within the AIG.

Feral Livestock: Donkeys

UNFEASIBLE

Criteria	Assessment	Outcome
Technically Feasible	The successful eradication of livestock has been shown to be possible on large islands using hunting as the primary means of removal. Due to the nature of the feral donkeys present on Ascension, they can be easily managed in a way that ensures their removal.	**PASS**
Sustainable	The sustainability of any eradication project relies on stringent biosecurity protocols to prevent reinvasion and re-establishment of target species after eradication has been achieved. The means of sustaining a feral donkey eradication on Ascension are considered feasible, and the risk of reintroduction is low due to the requirement for humans to facilitate their reintroduction.	**PASS**
Politically and Legally Acceptable	As Ascension is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The removal of feral donkeys is expected to be politically controversial and could only proceed with the backing of Ascension local government and administrative authorities.	**CONDITIONAL**
Socially Acceptable	Initial discussions with community members showed that the impacts of feral donkeys are disproportionately felt by community members in Georgetown. There remains a desire to keep feral donkeys on Ascension by some community members due to the historic and cultural connection. It is expected to require significant ongoing community consultation if the permanent removal of feral donkeys is a desired goal.	**FAIL**
Environmentally Acceptable	As feral donkeys would be removed using hunting as the primary method, the only environmental impact expected to arise from this would be the disturbance associated with the presence of hunters working across the island.	**PASS**
Capacity	A small team (4 people) of specialised hunters is considered sufficient to remove all individuals of the feral donkey population, due to their association with areas of human habitation.	**PASS**
Affordability	The removal of feral donkeys from Ascension would be in the region of £2,200,000. AIG may have limited funding in current budgets, but any full eradication is still likely to need funding from external grants or funding bodies.	**CONDITIONAL**

Feral Livestock: Sheep

FEASIBLE

(DEPENDENT ON CONDITIONS DETAILED BELOW)

Criteria	Assessment	Outcome
Technically Feasible	The successful eradication of livestock has been shown to be possible on large islands using hunting as the primary means of removal.	**PASS**
Sustainable	The sustainability of any eradication project relies on stringent biosecurity protocols to prevent reinvasion and re-establishment of target species after eradication has been achieved. The means of sustaining a feral sheep eradication on Ascension are considered feasible, and the risk of reintroduction is low as they can only return to Ascension if they are introduced intentionally.	**PASS**
Politically and Legally Acceptable	As Ascension is a UKOT, it is a signatory to the Convention on Biological Diversity and as such are committed to protecting island biodiversity. The removal of feral sheep is expected to have the support of local and national agencies on Ascension.	**PASS**
Socially Acceptable	Initial discussions with community members showed that the impacts of feral sheep are felt predominantly in Two Boats Village and Travellers Hill, where their removal is more greatly supported. There is still some opposition to the removal of sheep from those who do not experience these impacts, or who hunt them for meat and see them as a source of food. Ongoing community consultation would be required to further build support for their removal.	**CONDITIONAL**
Environmentally Acceptable	As feral sheep would be removed using hunting as the primary method, the only environmental impact expected to arise from this would be the disturbance associated with the presence of hunters working across the island.	**PASS**
Capacity	A small team (6 people) of specialised hunters using dogs to help track and corral feral sheep is considered sufficient to remove all individuals of the feral sheep population.	**PASS**
Affordability	The removal of feral sheep from Ascension would be in the region of £1,700,000. AIG may have limited funding in current budgets, but any full eradication is still likely to need funding from external grants or funding bodies.	**CONDITIONAL**

Feral Livestock Eradication

Technically Feasible

If either feral donkeys or feral sheep were to be removed from Ascension, they would have to be targeted using experienced hunters with prior eradication experience, specifically ungulate eradication. Successful livestock eradications on islands have been achieved using this methodology before on islands up to 63,300 ha in size using a combination of aerial and ground-shooting. (Heriot et al. 2019).

Due to the approachable nature of the feral donkeys on Ascension, and the fact that they are largely localised around Georgetown and the municipal waste site, their removal is considered feasible using ground-based methods, which would be considerably more cost-effective.

Feral sheep were observed predominantly in Two Boats Village and Travellers Hill, as well as around Green Mountain. Feral sheep populations around Green Mountain would likely require greater effort to successfully remove from more inaccessible areas of terrain, however, the eradication of feral sheep from Ascension is considered feasible.

Our recommendation is that both feral donkeys and feral sheep are considered for eradication from Ascension. Currently, both species increase the spread of invasive weed species across Ascension, providing abundant sources of alternative food and habitat for rats, mice and rabbits. Rats and mice are both identified as key drivers of native biodiversity loss and impact upon human welfare on Ascension, and any introduced species that facilitates the spread of these invasive species should also be considered for control or removal.

During the site visit, feral donkeys were observed to be in poor health, often malnourished or injured and were observed feeding at the landfill site, eating cardboard, human food waste, and becoming entangled in metal such as tins.

If either feral donkeys or feral sheep are not to be considered for removal from Ascension, they must be corralled and managed during any eradication project that uses toxins applied extensively across the island. Management of feral livestock in this way is necessary to avoid impacting them through direct or secondary consumption of toxins. It would be unacceptable to allow these animals to continue to roam freely during an eradication knowing that they would be impacted in this way. The ongoing corralling and management of feral livestock would increase the costs of a toxin-based eradication.

The expected benefits of removing feral livestock from Ascension are, but not limited to reduced spread of invasive plant species, reduced disturbance in townships, reduced damage to property associated with grazing animals and fouling, and no further suffering to animals experiencing malnutrition and disease.

Sustainable

If feral livestock were removed from Ascension, they could only be reintroduced by intentional release back onto the island. This would be very low risk due to the strict management of imports into Ascension, but the sustainability of any eradication could only be ensured if there is ongoing community consultation and education about the benefits of eradication. if members of the community were not supportive of the removal of feral livestock, it would be reasonable to expect that there would be reluctance to adhere to biosecurity principles.

Politically and Legally Acceptable

The removal of feral livestock, especially donkeys, from Ascension is expected to be politically contentious, and the feasibility of removing them would depend on support from local and national government. Considerations must focus on animal welfare, as well as their ongoing impacts to native biodiversity and human health and wellbeing.

Feral Livestock Eradication

Socially Acceptable

There are different opinions on the feral donkeys currently present on Ascension. Some members of the community see them as culturally significant, and a part of Ascension, while others feel they are a nuisance, causing disturbances and damage in settlements such as Georgetown. Due to current attitudes to the removal of feral donkeys, it is not currently considered socially acceptable, and is the main reason a feral donkey eradication is considered unfeasible at this time.

The removal of feral sheep from Ascension is expected to have greater support, though some resistance should be expected. This will require ongoing community consultation and input to identify the key issues and concerns around their management. After discussion with community members, there is more support for the removal of feral sheep from Ascension at this time, and so are considered feasible.

Environmentally Feasible

The removal of both feral donkeys and feral sheep could be achieved through ground-based hunting. The environmental impact associated with these methods are not expected to be high. Disturbance resulting from hunters working on the island would be the main consideration. The method of eradication must take into consideration the impact that any hunting may have on the community in those areas. Options to capture and transport the feral donkeys to a more secluded location for dispatch could be considered, to mitigate any impact this may have on community members if done in settlements where donkeys are present.

Capacity

A team of up to 6 hunters is considered sufficient to remove the feral donkey population due to their localised distributions near settlements and waste management sites on Ascension. If the removal of feral donkeys went ahead, once individuals began being removed it is expected that remaining individuals would become harder to approach and effectively remove, becoming averse to the presence of hunters. It may be more effective to corral some donkeys to act as an attractant to remaining individuals.

The same team of hunters could be used to target the feral sheep on the island, either concurrently with the donkeys in a joint operation (which is likely to save overall costs) or separately.

Affordability

The removal of feral donkeys is expected to cost £1,700,000 and the removal of feral sheep is expected to cost £2,200,000. If the donkeys and sheep were removed concurrently the operation would be more cost effective.

ALTERNATIVES TO LETHAL CONTROL OR ERADICATION OF LIVESTOCK

Improved management of feral livestock on Ascension could be a viable strategy to reduce the impacts associated with them, without resorting to lethal control. It must be understood however, that unless all individuals of the species are removed or contained within a management area, then impacts associated with their presence on Ascension will continue.

1. Sterilisation of either one or both sexes could allow the feral population to remain on the island until such a time they naturally die out, due to reduced breeding rates. This approach would require a veterinarian to be employed to sterilise and monitor the herd.
2. Establish an area for their containment and management. If the community wish to keep donkeys and/or sheep on Ascension, then this option could provide the animals the opportunity to live in better conditions, with more nutritional food and fresh water. This would require someone who had overall responsibility for the donkeys or sheep in that paddock.

Any animals managed in a fenced area would require veterinary care to ensure that they were in a healthy condition. During an eradication that uses toxins, bait stations should be used in and around the enclosure, to minimise the risks of poisoning the livestock. A veterinarian should be employed by the project to help manage antidotes and administer treatment if required. This role could incorporate the requirements of livestock management if so desired.

Non-Target Species

Any eradication or control project has an associated risk that non-target species will be accidentally poisoned or affected by the eradication programme. This may be through direct consumption of bait, secondary poisoning (feeding on organisms that have consumed bait, i.e., carcasses), or indirect effects (such as trampling or disturbance). Programme planning must identify species at risk and establish preventative measures to minimise risk, such as those outlined in Castaño et al. (2022).

On Ascension, observations of potentially impacted mammal, bird, and invertebrate species were made, and the risk posed by a rodent eradication operation was evaluated. Further information of these non-target species are given in Appendix 7.

The principal preventative action for primary poisoning (i.e., direct consumption of bait) is the exclusion of non-target species. This can be achieved either by using bait stations in a ground-based baiting operation or by management of non-target species to limit access to any openly laid bait. Bait trials should be run prior to an eradication operation to determine the level of non-target species interaction with bait stations and the bait itself, and the eradication strategy adapted to overcome any issues identified (i.e., bait type, bait station design, baiting strategy, etc.).

There is a risk of secondary poisoning for non-target species that scavenge rat carcasses such as birds, or domestic cats and dogs. In most circumstances, rats will die either underground or under vegetation in their nests and burrows, but tropical islands eradications often see high numbers of “surface rats” (i.e., rats that have died on the surface). There were 160 rat carcasses found on Dog Island (Bell 2012) and 117 rat carcasses found on Redonda (Bell et al. 2017). These higher number of carcasses increase the risk to scavengers and should be monitored throughout any eradication operation. High numbers of surface rats were observed on Ascension during the feasibility assessment trip resulting from current control efforts (L. Titterton, WMIL, pers. obs.) confirming risks to non-target species are already present. Steps should be taken to limit the risk carcasses pose to non-targets such as collecting and incinerating any carcasses found above the surface.

Invertebrates, especially crabs, can consume high levels of brodifacoum bait without ill effect (Alomar et al. 2018) The effects of brodifacoum on Ascensions land crabs has been studied by Pain et al. (2000) who showed that crabs rapidly excrete the toxin from their bodies without ill-effect. Invertebrates are not generally affected by brodifacoum, though will accumulate toxins within their tissues and can lead to bioaccumulation through the food chain. Additionally, invertebrates will compete for bait with rats and can prevent rats from accessing lethal doses (Keitt et al. 2015).

Despite all preventative methods, incidental loss to non-target species may occur. This should be balanced against long-term benefits to native species and ecosystem recovery.

Improving Current Rodent Strategy

The eradication of some pest species from Ascension is considered feasible, conditional on several factors such as funding and team size. A project of this scale will require a significant planning phase that is likely to take several years. As rodents were identified by the community as a priority concern due to their impacts on island infrastructure and community wellbeing, recommendations for developing an efficient strategy to improve the control of rats and mice are given (see Page 46).

Current workload

The current team of three EH employees have a high workload. They are tasked with managing the existing rodent control bait station network, conducting water quality testing, cleaning and maintain the swimming pool at Two Boats Village, responding to callouts to collect trapped rodent carcasses, and invertebrate pest control. As a result, they are already working to capacity and cannot further increase rodent control efforts effectively. It is therefore advised that EH employs two additional team members who are responsible for full-time rodent control on Ascension. This will ease the workload of the current team, allowing them to maintain their existing workload, but will allow a more efficient rodent control strategy to be implemented.

Specialist skills and training

WMIL recommend that the EH team are trained to best practice in rodenticide use and handling. Not only will this improve the health and safety aspects of handling rodenticide, but it will also allow for more efficient rodenticide use which can reduce costs, and further reduce risks to non-target species. Training in rodent monitoring methodology and rat necropsy would also be valuable.

It is also recommended that the EH team undertake bespoke rodent control training which will provide them with the skills and knowledge to respond to fluctuations in the rodent population before they become problematic for the community. Bespoke rodent control training will allow the team to collect more accurate data relating to bait take and to the rodent populations on Ascension, which could provide valuable baseline data for any future eradication projects.

Figure 4. Environmental Health personnel being trained by WMIL personnel in rat necropsy methodology, Ascension Island, January 2024.

Improving Current Rodent Strategy

Waste management

The landfill site on Ascension is a current source of food for rats, mice, myna, donkeys, and sheep. Discarding food waste in an open pit is creating the perfect opportunity for pest species to increase in abundance, regardless on whether the food waste is burnt or not (Figure 5) The landfill is the greatest concern for any eradication project and is highly likely to be a source population on Ascension, with rodents continuously dispersing into the surrounding areas as breeding occurs. The available food source will enable rodents to be maintained at an artificially high level. Improving waste management practices here should reduce rodent numbers at this site and the surrounding area.

***Figure 5**. Unopened and expired food discarded at the Ascension Island landfill (this occurs most days).*

The presence of the donkeys and sheep at the landfill site is not only concerning from an animal welfare standpoint, but it also exacerbate the rodent problem as the larger animals disturb the food waste pile as they forage, exposing more of the buried food and providing more feeding opportunities for rodents and myna. Hand broadcasting, or otherwise disposing of rodenticide into the landfill site is not a recommended method for controlling the rodent populations. Due to the presence of feral donkeys and sheep at the landfill site, the risk to these species of becoming accidentally poisoned is too high.

If rodenticide is disposed of or placed at the landfill site, there are too many alternative food sources which will reduce the likelihood of any individual rat consuming the required lethal dose of rodenticide. Furthermore, as several different species all forage at the landfill site, competition for food will be high. If rodenticide is used/disposed of at the landfill, this competition will again reduce the bait availability for any one individual to consume a lethal dose required. These factors can all lead to the development of bait resistance, which would make any future eradication more difficult. Bait resistance can occur through the development of genetic resistance (i.e., individuals in the rodent population develop a genetic resistance to the toxin), or through a learned aversion to the bait itself (i.e., rodents consume sub-lethal doses and feel sick, learning to avoid consuming the bait again).

Rather than waste rodenticide products at the landfill site, effort should be focused on improving waste management systems on Ascension so that food waste is incinerated daily and not left out overnight. Should the waste management system shift to incinerating all food waste at the incinerator, the current landfill site should be burnt and buried to discourage continued feeding.

Improving Current Rodent Strategy

Recommended baiting strategy

The current bait station network is too large for a team of 3 people to bait efficiently. During periods of high rodent activity, the EH team are forced to prioritise baiting at the settlements and around infrastructure which results in some areas, like the roads and the walking tracks, being baited every 6 to 8 months . Reducing the bait station network to focus on the settlements and areas of human activity will reduce the workload on the EH team, allowing them to bait around the town more frequently, keeping the rodent numbers at a more manageable level.

RECOMMENDATIONS FOR IMMEDIATE CHANGE ARE:

- All bait stations along roads are removed.
- Bait stations on Elliot's path are checked, with all damaged or unsecured bait stations replaced with new and secured in position.
- Brodifacoum and flocoumafen are no longer used as these are the best options for eradication operation. If resistance develops to these, then eradication will be unfeasible.
- Wire rods are used to secure bait into all bait stations.
- All EH staff conducting bait station checks must carry a waste bait bag to collect and remove all waste bait.
- Any bait that is mouldy, chewed, or has melted, should be removed and replaced.
- Waste bait should be incinerated.
- All stations are serviced according to Bait Station Servicing and Data Collection SOP (Appendix 10).

RECOMMENDATIONS FOR NEW BAITING STRATEGY ARE:

- An intensive baiting grid (50 x 50 m) is established at Two Boat and Georgetown settlements.
  - Eight blocks of bait are placed in each bait station.
  - Bait stations in settlements are serviced weekly.
- An intensive baiting grid (two 50 m x 50 m perimeter lines of bait stations) is established at all public beaches and picnic areas.
  - Eight blocks of bait are placed in each station.
  - Bait stations are baited every 3 months, over four weeks using bromadiolone bait:
    (a) Week 1 - all bait stations are baited, 8 blocks (2 blocks on each wire)
    (b) Week 2 - record bait take and replace bait as required.
    (c) Week 3 - record bait take and replace bait as required.
    (d) Week 4 - record bait take and remove all bait.
- All stations are serviced according to Bait Station Servicing and Data Collection SOP (Appendix 10).

Rainfall monitoring

Heavy rainfall events on Ascension can trigger the widespread germination of rain grass (*Aristida ascensionis* and *Enneapogon cenchroides*), which in turn, provides a sudden influx of food for rodents. Establishing rainfall monitoring stations on Ascension will allow the EH team to better predict where rodent populations may increase in response to higher natural food availability and respond to these influxes by focusing their baiting efforts in these areas.

Self-resetting traps

For some locations, such as the campgrounds, beaches and walking tracks, bait stations could be replaced with self-resetting traps like GoodNature A24 traps (https://goodnaturetraps.co.uk). This will reduce the use of toxins in these areas, and the associated risks to non-target species. Trials to determine their suitability for use on Ascension should be conducted. However, A24 traps require gas canisters to operate, and will therefore have to be transported via boat onto Ascension which will take time. This may impact their suitability for use on Ascension.

New Technology: Drones

The pest management toolbox has increased with technological advancements to assist conservation and environmental projects. Drone (or Unmanned Aerial Vehicle, UAV) technology is improving in development, fine tuning, and overall performance to deliver the necessary techniques in invasive species eradications and/or the potential for conservation monitoring. The expectation for drones to be used as a conservation tool in this space is becoming increasingly common.

Most peer-reviewed studies on the use of drones come from their use in the agricultural sector (e.g., invertebrate management on crops), but this is being increasingly adopted by ecological restoration initiatives (Robinson et al. 2022). The use of drones can have exponential gains in efficiency and scalability in eradication programmes (Island Conservation 2023) and may assist with ongoing control programmes. However, it is vital that the use of drones is assessed for suitability for invasive species eradication at each island location.

To date there are few reported successes, and only a small number of documented global projects, that have used drones in eradication programmes on islands to carry out tasks such as aerial baiting. These have predominately involved deploying cereal bait to target rats on small islands (i.e., up to a few hundred hectares), such as North Seymour Island (Galapagos, 184 ha) (Marris, 2019).

Drones: Pros and Cons

There are many pros and cons for the use of drones as an eradication tool comparable to that of other techniques such as ground-based "boots on the ground" or aerial operations using helicopters.

Drones: Pros

Drones are becoming increasingly advanced with respect to their imaging capabilities, which is a primary benefit from their use. Light Detection and ranging (LiDar) capacity (Cameretta et al. 2020) can be used to map terrain and inform bait coverage; object recognition algorithms can monitor habitats and species (Dalla Corte et al. 2020), and multi-spectral sensors such as thermal infrared cameras can enable monitoring of otherwise difficult to observe species (Burke et al. 2019)

Drones are likely to be a more cost-effective option for aerial baiting operations when compared to helicopters owing to the reduced need for transporting and housing a helicopter on island. For Ascension, any helicopters would have to be transported to the island, either via ship or by plane with aircraft carrying capabilities and would have to be housed at the Wideawake Airfield where suitable facilities exist for the storage and maintenance of aircraft. By comparison, drones can be relatively easily transported onto the island as cargo and stored at personnel accommodation for the duration of the project.

In areas with dry, dusty and loose top-soil, brown-outs caused by the helicopters' downdraft have been identified as a risk by helicopter operators in previous island eradications. Re-loading helicopters on Ascension would therefore be restricted to sites where this risk was not present (i.e., the airport) and would require input from an experienced pilot to identify any other suitable locations where reloading could take place. Alternatively, drones can be operated from much smaller launch areas and are less impacted by brown-out conditions.

For both drones and helicopters, personnel with expertise in delivering such operations will be required not only to pilot the craft, but to advise the equipment selection process (i.e., drone type, bucket types, GPS system requirements), and any risks to aerial operations such as wildlife interactions (Edney et al. 2023). Additionally, drones and helicopters can be operated in areas which may be otherwise impossible or challenging to access by foot (Scarton & Valle 2020), can be deployed from most terrain types including boats meaning land-based operation may not be required (Dickens et al. 2021), and provide opportunities to acquire habitat mapping for real-time planning of operations and georeferencing (Pfeifer et al. 2019).

New Technology: Drones

Drones: Cons

Disadvantages to drone use include their capabilities becoming limited by high winds or rain (Corcoran et al. 2021), with higher winds impacting upon the drones overall flight time and flight speeds which impact sow rates. Operators have also reported that drones can drift due to wind. These factors mean that bait coverage can be inconsistent throughout the course of the aerial bait application and require further flights to achieve the desired coverage (Department of Conservation (DOC) 2023). Poor weather conditions can not only affect sow rates and distribution but decrease visibility leading to distorted images, but also places risks to the pilots' control over the drone (Doukari et al. 2021)

Drones require lithium batteries to function which is currently a disadvantage to baiting operations due to the required charging time which can cut into operation time. When operating in remote locations, having sufficient means to recharge the batteries is essential. It is important to either have multiple batteries per drone to use or have recharging capacity on site to avoid returning to base. This may mean the logistics of transporting petrol generators to the site to allow for on-site charging of batteries. Furthermore, logistical factors need to be considered. Lithium batteries can only be transported commercially by land or sea which is time consuming. Other options to prolong battery life include decreasing payloads and increasing the number of flights conducted, however this may inevitably mean more frequent re-baiting (DOC 2023).

Drone use can be limited by the requirements of using other technological plugins such as pre-programming and attributing software, and the need to rely on power sources or petrol generators to provide electricity for battery charging. The limitations of flight time and battery capacity are increasingly evident for payload drones when the target area for bait application increases beyond 100 ha, and recommendations are to use multiple loading sites or multiple drones to maintain efficiency (DOC 2023). Aerial baiting using drones on Kamaka Island (57 ha) required 284 flights, 9 days to complete, 6 sets of batteries, and at least 8 staff to operate continuously (DOC 2023).

An additional consideration for the use of drones on Ascension is that resupply stations are recommended to be within 2 km of the area being baited (DOC 2023). This maintains efficiency and allow the pilot to maximise flight time for the baiting itself. Helicopters hold an advantage over drones in this respect as they can typically carry large loads over great distances, therefore reducing the need for them to return and land to re-supply.

Payload drones

Currently, a key focus of payload drone technology is increasing payload capacity whilst limiting compromise on other key attributes such as battery life. Larger payload capacity will mean higher deployment rates, and increased rates along with improved flight duration will be vital to delivering larger scale eradications. Helicopters are currently capable of carrying payloads up to 900 kg (depending on aircraft specifications), while drones can carry payloads of 12-50 kg. Envico Technologies Ltd. (https://www.envicotech.co.nz/) are currently developing drones which will enable payloads of 200 kg to be carried (DOC 2023). This will allow for greater bait coverage during a single flight and reduces the need to return the drone for re-loading with bait. However, this presumes that battery endurance will also be developed to achieve this.

Generally, when compared to helicopter operations, drones can deploy bait with improved accuracy and consistency when operating along pre-programmed flight paths. They have the ability to bait at precision across flat terrain, trickle along boundaries or deploy specific baits individually meaning there are increased opportunities to explore a targeted approach to bait deployment. To date most operations have applied cereal bait at a rate of 40 kg/ha to target rodents (DOC 2023).

Companies such as Envico Technologies Ltd have developed bait spreading techniques which can vary the bait dispersal patterns, swath (full spread or directional spread), and trickle or cluster baiting. This improves the planning of the bait drop (Duval 2022) and therefore reduces the number of flight paths to be generated (Hoffmann et al. 2023). Similarly, when drones are compared to manual (hand-broadcast) bait deployment it again offers a more even distribution of bait, reduced time application, and reduction in the personnel required to do so. There could be potential for the use of drones in this way on Ascension to apply bait around the boundaries of settlements while the interiors are baited by hand or bait station.

New Technology: Drones

Drones: Payload drones

This can be particularly effective in larger scale operations where remnant pest populations can be costly to 'mop up' with ground-based operations (Holmes et al. 2015).

When it comes to eradication, deploying bait at an even rate and distribution is important to avoid clumping or patchy distribution which can increase both the risk of eradication failure if target species don't have access to lethal doses, as well as non-target species risk.

Monitoring with drones

To ensure the successes of island restoration projects, tracking and monitoring target species is an integral element. Terrain can present challenges to conducting this monitoring work on the ground and drones can overcome these issues (Island Conservation 2022). Being able to evaluate the efficacy of the management techniques used is vital. When proof of absence is required at the end of an eradication operation, it is expected that drones could be used to monitor inaccessible sites for the presence of any remaining individuals of the target species.

For rats, this could be achieved through the use of drones with thermal imagery capabilities. There may be some limitations in this approach due to target species behaviour, habitat use and the influence of ambient heat on target species detectability (T. Hart, Seabird Watch, *pers. comm*.), but consistent monitoring over key sites pre-, during, and post-eradication could be valuable to determine eradication success. Drones may prove useful when paired with other monitoring measures such as transect lines, trail camera monitoring, or tracking tunnels.

Surveys conducted by drones can be repeated easily due to programmable flight paths allowing exact flyovers of the same areas to be replicated. The platforms have become easier to use to gather better quality spatial and temporal data from the air (Edney et al. 2023) whilst providing high quality images to that provide visual references. As eradications aim to benefit both flora and fauna, there are opportunities to explore drone use to assess landcover/vegetation changes, landscape characteristics, and species abundance over time as a result of eradication by creating spatial and temporal reference imagery. Image analysis is predominately manual but automated processes using Artificial Intelligence (AI) are being developed that may reduce time requirements. Additionally, drones can be less disruptive to wildlife than on-the-ground survey methods (Sarda-Palomera et al. 2012), can complete surveys in less time than ground-teams, and capture imagery that can be reviewed for further interpretation.

Overall, it seems drones are growing in importance for implementing conservation management and monitoring programmes. In the interim, as technology advances to allow more eradication projects on islands of larger scale, considerations might be that drones can be used for monitoring tools as well as bait deployment tools.

New Technology: Drones

Drones on Ascension

Based on discussions with the different agencies and community members on Ascension during our site visit, it is expected that the use of drones, in any capacity (baiting or monitoring), would be a viable option. The main factors that are expected to limit their use on Ascension include the designated no-fly zones, interference from frigatebirds, and the prevailing weather conditions experienced on the island.

Much like helicopters, drones are expected to be restricted in their use in or around no-fly zones. Outside of the USSF designated no-fly zones (e.g. where we have determined a limit to helicopter flights over settlements), drone flights should be less restricted, but will require consultation with the community to ensure they are supportive of this method if chosen. Discussions with both militaries around the use of drones in this way should be made to determine if the same no-fly restrictions would also apply to the use of drones for aerial baiting. If the opportunity to use drones within these zones exists, it is expected to save time that would otherwise be required in a ground-based approach.

During the site visit, discussions with the Conservation Department staff confirmed that frigatebirds will target drones in the air between altitudes of roughly 10 to 100 meters (L. Shearer, Conservation Department, AIG, pers. comm.). Successful aerial baiting operations using drones have worked with drones operating at heights of 170-250 meters (DOC 2023), so this interaction can hopefully be mitigated for on Ascension. Field tests would need to be trialled to ensure that bait application rates on the ground could be achieved at the required bait density for successful eradication. Due to the presence of multiple bait competitors (i.e. mice, rats, crabs, and rabbits), a higher bait density would be required to successfully target any of these species due to high levels of competition for bait.

The prevailing wind conditions on Ascension would impact upon drone operations by decreasing flight times and impacting upon bait sowing rates. Consultation with drone pilots experienced in aerial baiting would provide valuable information on the impacts that prevailing wind conditions would have on an eradication, and whether these impacts would make the proposed baiting with drones ineffective.

If drones are considered for bait application on Ascension, it is anticipated that their use would be focused in areas that have the greatest risk associated with a helicopter-based bait application. Several cliff sites around Ascension are expected to be too high risk for helicopter pilots to safely apply bait near the coast due to the potential for rock fall and brownout conditions that could result from the helicopter downdraft (though consultation with experienced helicopter pilots is recommended to confirm this). This methodology would allow the drones to be used more effectively over smaller areas similar in size to projects where drones have been proven to successfully achieve eradication (DOC 2023).

Due to the limitations on flight distance resulting from battery capacity, it is expected that drone operations will require bait stores to be located within 2 km of the area being baited (DOC 2023). This needs to be considered with respect to how many bait stores may be required on Ascension, where stations would be best placed, and how frequently operational personnel would need to relocate themselves or fly the drone/s to nearby re-baiting stations. Due to the size of the island, it is likely that multiple bait stores would need to be established to operate within these recommendations. This would make it logistically simpler in terms of operating the drone (no need for the operator to change location) but would increase the logistical requirements for transporting and storing bait at multiple sites around Ascension.

New Technology: Immunocontraceptive

What are immunocontraceptives?

A rising field of wildlife management research is looking at the suitability of immunocontraceptives as a means of controlling populations without resorting to lethal tools such as traps, shooting, or poisoning. Concerns regarding animal welfare and public safety where pesticides are used have led to increased discussion about the suitability of immunocontraceptives as an alternative on Ascension, with several community members asking about their suitability for control or eradication of rodents.

An immunocontraceptive works by generating an immune response within the target individual that attacks the proteins within the individuals own reproductive cells, leading to sterility. There are different mechanisms through which an immunocontraceptive can be administered such as an injectable vaccination, viral vectors, and oral treatment. Injection of individuals is impractical when targeting wild populations, as it relies on capturing and treating individuals, a labour intensive and costly process. Using a virus to help transmit the immunocontraceptive amongst wild house mice populations has been shown to be viable, though concerns about the ability to monitor its spread were raised, with potential resistance to either the vector or autoimmune response being one such roadblock (Redwood et al. 2007).

An alternative option that may be more effective for use amongst wild populations of rodents such as those on Ascension uses an oral application of the immunocontraceptive, often presented as a bait that the target species consumes. Advantages of oral immunocontraceptives include high immunisation coverage, easier administration, and cost-effectiveness (Yang et al. 2022). Disadvantages include ineffective bait design and delivery systems, and target species biology resulting in the breakdown of the immunocontraceptive proteins before an immune response can be produced (Yang et al. 2022).

Immunocontraception use on Ascension

The landfill site on Ascension supports exceptionally high rodent populations and could therefore be a suitable location to trial the use of immunocontraceptives. The use of rodenticide at the landfill site to control rodent numbers is unlikely to succeed due to the population level and availability of alternative food sources. The use of rodenticides here could lead to the development of bait resistance, resulting either from genetic (i.e., rodents are genetically resistant to the toxin) or behavioural (i.e., rats learn to avoid bait) resistance.

While immunocontraceptives are not yet proven to successfully eradicate rodents from islands, they could be an option for improving short term control of rodents, with greater effectiveness when used with other tools in an integrated pest management approach. Pyzyna et al. (2014) report that a liquid bait designed to inhibit fertility in rats was readily consumed where there were abundant sources of alternative food and water in urban rat populations. Caution is advised when interpreting these results however, as only 51% of the captured population were found to have consumed the bait, and just 58% had taken the bait more than once (Pyzyna et al. 2014). This may not translate to effective rodent management in large populations.

Further field trials studying the efficacy of ContraPest®, a liquid immunocontraceptive bait, showed that when combined with a rodenticide baiting strategy, improved rodent control for brown rats was achieved. Unfortunately, this improved success rate appeared to be short-term, with many locations that trialed this method returning to standard rodent control measures such as using rodenticides to maintain low numbers (Spencer 2014). Field studies investigating the use of immunocontraceptives have also not been conducted on ship rats, and there are expected to be significant differences in both the acceptance of the bait and effectiveness of the immunocontraceptives in achieving reduced rodent population size. Discussions with EH staff revealed that a liquid bait trial on Ascension had been conducted previously, and that bait uptake was low (C. Anthony, EH AIG, pers. comm.).

If immunocontraceptives are used on Ascension, they are not expected to achieve control on their own and should be used as one of several tools as part of an integrated pest management approach. Studies have shown that rats can regain fertility after being exposed to the immunocontraceptive (Pinkham et al. 2022), meaning that control will only be achieved for as long as baiting efforts are maintained.

A summary of mammalian pest control tools is given in Appendix 11.

Areas of Research

As the feasibility of eradicating some species is conditional on other factors such as community support, new technology, or understanding current target species ecology and biology, a focus on building this knowledge base to support eradication in the future should be prioritized. Below are recommended areas of research to support future eradication attempts.

Recommended areas of research

1. **Habitat Mapping.** Detailed habitat maps would be useful for informing management decisions. These should be combined with previous studies into pest species habitat use and diet. Some target species (ship rats and house mice) are more abundant in areas where invasive plants such as Mexican thorn are present. Mapping these species would inform management strategies aimed at eradicating or controlling these species. Habitat mapping could also include cave entrances that may not be effectively baited by an aerial operation.
2. **Climate data and pest species abundance.** Climate can affect target species abundances, especially rodent species (Marini et al. 2023) with rats and mice able to respond rapidly to increased food availability due to weather events. AIG staff and community members described a wet weather period that had been experienced on island in recent months, and vegetation growth resulting from this was apparent. Quantifying the effect that wet weather can have on vegetation across the island and therefore target species would be beneficial to eradication planning.
3. **Consolidation of existing information.** As Ascension has had numerous research projects investigating invasive species on the island, it would be valuable for future eradication planning that this information was collated into a single review document, describing the ecology and biology of invasive species on Ascension.
4. **Socio-economic Research.** The implementation of a large-scale eradication on Ascension would have significant impacts on the local communities for the duration of the eradication. Large teams of staff that are likely to be required to successfully complete an eradication will place a strain on island resources. There would be a requirement to develop accommodation for project teams, that could then be passed on to the community once the eradication has completed. Other eradications on islands with communities can build a legacy that has a variety of benefits for the island's community, lasting beyond the lifetime of the eradication itself.
5. **Predator Proof Fencing.** One conservation tool that could be implemented on Ascension are predator-proof fences. As the removal of feral cats has resulted in increased predation of seabirds from rats (Hughes et al. 2019), predator-proof fences could be a cost-effective method of improving productivity for affected seabirds in smaller, more manageable areas. Species most likely to benefit from predator-proof fences are sooty terns and storm petrels. The AIG's seabird research staff discussed the potential for developing storm-petrel habitat at the Letterbox Nature Reserve. As storm petrels are highly susceptible to predation by rodents, any area designed to provide breeding habitat for storm petrels would need to be within the confines of a predator-proof fence. This would require further investigation to determine a suitable site, methods, and materials required for its successful, and long-term placement.

Monitoring

There are several monitoring efforts that should be progressed throughout invasive species management programmes that include the monitoring of the pest species themselves, as well as monitoring land birds, seabirds, invertebrates, reptiles and vegetation across the range of habitats on the island. A detailed monitoring plan should be prepared to ensure relevant and accurate data collection, data storage and analysis. Historical data should be used, where available, to help establish baseline levels and distributions of pests and native species. Ideally pre-eradication monitoring should be conducted for at least one year prior to project commencement. **Current monitoring methods that are implemented by the AIG's Conservation Department are effective and should be continued and developed with new learnings.**

Pest species monitoring

Monitoring pest species can be progressed from initial trapping and bait station data collected to date by EH. Trap captures and bait take can be indicative of pest species abundance, with higher rates of trap captures and bait take relating to higher abundances. Additional monitoring methods that can be employed include:

Rodents:

- Predator tracking rates using tracking cards, to determine distribution and abundance of rats and mice across a range of habitats and seasons.
- Number of trap catches/effective trap nights. Trapping indices can help estimate population densities in certain habitats.

Rabbits:

- Dropping counts can be used to estimate rabbit population size, though this will become more difficult to accurately estimate population size when numbers are low, as caused by a disease outbreak.

Myna:

- Point counts conducted in a consistent and regular schedule can help to track population changes over time. As with rodent eradications, targeting myna will be most effective when their population is naturally low. Monitoring will reveal when, if any, population decline occurs and can inform the timing of an eradication operation.

All invasive species:

- Camera detection data can be useful as a simple detection tool (presence/absence) as well as capturing behaviour, which may be useful when new trap or bait station designs are being used, to monitor interaction.
- Genetic analysis can detect presence of disease such as RHVD as well as resistance to pesticides. This is useful information to have before a baiting operation and can inform bait choice and strategy. Rat tail and whisker samples (n=52) collected during the site visit have been sent for analysis. The outcomes of this analysis will be shared with AIG when available. This will help to provide baseline data on the genetic profile of the Ascension rat population and will detect bait resistance if present.
- Trialing new technologies/tools and collaborating with other agencies and research institutes to trial new technologies could yield valuable results that benefit pest control projects and develop a valuable network of researchers, practitioners and communities. Examples include the use of thermal cameras, audio lures, and AI image classification systems.

It is important that all monitoring methods cover a variety of habitats and seasons to gain a clearer picture of how target species are using the habitat available throughout the year. This information can inform future eradication strategies.

Pre-eradication Requirements

Prior to an invasive species eradication, various areas of research and preparation should be undertaken to ensure any future eradication attempt is in the best possible position to succeed. These can include community consultation sessions, establishing required land access, field trials of recommended tools and technology, and waste management audits among other tasks. Examples of useful information that will need to be gathered or addressed prior to an eradication are detailed below. The list is not exhaustive and should be reviewed considering new developments and learnings.

Climate and vegetation monitoring

Ascension can experience unusually heavy rains and as a result a flush vegetation growth can rapidly increase. Two grasses, *Aristida ascensionis* and *Enneapogon cenchroides*, are well adapted to respond to these conditions and their seed may lie dormant for many years. These grasses are known locally as rain grass because of their rapid germination following spells of heavy rain. Rodents and rabbits are quick to respond to this sudden flush of vegetation which typically leads to their populations increasing.

The relationships between increases in natural food availability and rodent populations have been studied. In New Zealand, ship rat abundances are seen to increase roughly three months after a significant seed mast event, where seed availability increases in late autumn, and rodent trapping rates increase in the following spring (Harper 2005). On Ascension, a similar relationship could be expected to occur between rainfall, subsequent vegetation growth, and pest populations.

Monitoring precipitation on Ascension to anticipate vegetation growth and subsequent population increases in rodents, could help the EH team to respond more efficiently to issues around increased rodent populations.

Establishing additional rainfall monitoring stations at different sites across the island would provide a more accurate picture of where and when increased pest activity may occur and could inform the timing of an eradication project. Ideally, bait would be laid when the pest population is food stressed, and natural food availability is low.

Community support

An eradication project can only be feasible with the support from the community. Any ground-based aspect of an eradication project will need access to properties to ensure rodents are being targeted efficiently in all habitats and microhabitats. To gain support for such a programme it is recommended that a community consultation period is factored into the project planning. The consultation period is to educate residents on the reasons why this project is important, why access around properties is important, how they can help and what the project will do to ensure the safety of the community.

Prior to an eradication, there are steps that the community will need to take to prepare for an eradication project. One of these steps is to remove any potential rat harbourage and alternative food sources. This means that households and businesses will need to adopt strict waste management protocols. A team of experienced community engagement officers can help facilitate this shift. A case study on the Isles of Scilly, where a community led eradication of brown rats was successful, is provided on page 61.

Access

Some areas of Ascension are identified as no-fly zones and will require military authorisation for a ground team to enter and operate. For these sites there is the option to either train military personnel in eradication requirements or put project staff through the required security clearance protocols to gain access.

Pre-eradication Requirements

Helicopter

An aerial baiting operation relies on helicopters spreading bait across the designated areas on the island for several months. To plan an operation of this scale it is recommended that the project contracts pilots with experience in island eradications to complete an assessment of the requirements for the proposed eradication. This would allow the pilots to fully assess the scope of the job, including risks, limitations and running costs, and provide expert advice on how helicopters may operate on Ascension within the context of an eradication.

Complications may arise due to the presence of breeding seabirds, areas with tall structures such as high radio frequency antennae, or brownout conditions due to dry and dusty soil. Therefore, consulting with skilled pilots in the early planning phases of an eradication operation is essential. It may be necessary to test fly some areas on the island to assess impacts with seabirds, and to trial non-toxic bait spreading to ensure the required bait coverage can be achieved in challenging areas.

The helicopters and spreader buckets will need to be brought into Ascension either via vessel or aircraft. They will then need to be housed on Ascension for the duration of the operational phase of the eradication project. Discussions with the Wideawake Airfield should be started to better understand the costs and process for this. Alternatively, helicopters, bait, equipment, and some project staff could be housed onboard a vessel that is moored offshore for the duration of an eradication, although this is expected to incur significant extra cost.

If the helicopters cannot operate over sections of steep ground due to the presence of seabirds or risks of brownout conditions, it may be necessary to employ rope access and mountaineering techniques to hand-broadcast baits into hard-to-reach places. if deemed necessary, it is recommended that a fully qualified rope access team are contracted to assess the options for accessing steep ground for baiting. This would only be a requirement if an assessment by a helicopter pilot identified areas of the island that could not be covered by aerial bait drops.

Equipment storage

There will be a considerable amount of equipment needed for an eradication operation on Ascension, and this will need to be securely stored in a safe and accessible location. Rodenticides must comply with the manufacturer's safety data on storage and safe handling, this means that bait will have to be stored in a secure, well-ventilated, fireproof container. Prior to an eradication project there should be a procurement of equipment phase built into project planning. This procurement phase must also account for the length of time it takes for get items to be delivered to Ascension. Spare equipment should also be budgeted for and kept on Ascension. With the scale of an eradication on Ascension it may be necessary to obtain more vehicles on island.

Pre-eradication Requirements

Project team

The project team size will vary depending on the species targeted for eradication. The largest team required will be for a mouse eradication, with up to 110 ground personnel needed in the best-case scenario. The eradication of rats will need 35 ground staff, while the number needed for rabbits would depend on the rabbit population levels at the time (between 15 and 35 staff). Myna are expected to require 12 ground staff and livestock up to eight staff (minimum of four for donkeys and 8 for sheep). Ground staff total numbers include Field Team Leads/Supervisors.

For any aerial aspect, an additional team of 14 helicopter personnel (i.e., aerial operations manager, pilots, engineers, ground crew) would be required. The helicopter team will be responsible for conducting the aerial baiting, loading bait into the spreader buckets and monitoring bait coverage.

For livestock management, an additional four-person team including dogs, to aid in rounding up livestock, will be required to target or manage feral sheep and donkeys. It is important to note that dogs can only come from the UK and/or St Helena and are subject to biosecurity licence.

Additional to the core field team for any eradication, a Project Director, Project Manager, Operations Manager(s), Communications and Media Officer, and Community Liaison Officer will also be needed.

The Community Liaison person will be vital as there will also need to be ongoing community consultation to gather access consents and addressing concerns. An engagement and communication strategy will be required.

A veterinarian should be employed by the project who would be responsible for managing supplies of antidotes and administering treatment if non-target species were suspected of becoming poisoned during an eradication. A project of this scale will also require an administrative team to manage the logistics of such an operation and data management team to .

Once final team numbers are confirmed, accommodation will need to be secured. This would likely require the refurbishment of existing infrastructure to make them suitable for team accommodation. This would need to consider the possibility that historic building materials (i.e. asbestos) would be present and would require safe disposal. Alternatively, a vessel moored offshore during the eradication could provide accommodation for the team, though weather and sea conditions may impact the ability to transport team members back and forth each day. It is recommended that options for accommodating the team on Ascension are researched as the preferred option.

Biosecurity

Eradications are only feasible if they can be sustained in perpetuity. Stringent biosecurity measures, building on the Ordinance currently in place, would be required at all ports of entry on Ascension. Additional biosecurity measures could be implemented prior to visiting Ascension (i.e., departures from St Helena, South Africa, USA and UK). Biosecurity need to be established prior to any baiting to limit the chances of invasions. These measures could include checking cargo for stowaways, training staff to recognise signs of invading pests, using rope guards on all vessels that dock at Ascension, employing biosecurity detection dogs, and ensuring that cargo is loaded into rodent-proof bins.

The Biosecurity Ordinance currently in place on Ascension will help prevent the introduction of any new invasive species or pathogen, but communications between all parties needs improvement to clarify roles and responsibilities. A comprehensive island-wide biosecurity plan should be produced in collaboration with all agencies and interested parties on Ascension.

Pre-eradication Requirements

Waste management

Current waste management practices on Ascension vary between organisations. The US military base incinerate all waste each evening and clean the waste incinerator weekly, which is an example of excellent waste management practice, resulting in far fewer issues relating to pests around this waste management site. The AIG also run an incinerator but on a less regular schedule. This is mainly for the disposal of household waste though there has been reports of unsuitable waste (glass bottles) being included in these disposals which has resulted in explosions that have affected incinerator performance and the safety of its operators. Educating the community in correct household waste management would help to overcome some of these issues, though this would take time to adjust community habits and would likely be met with opinion that waste should be sorted at the waste management facility. Improving recycling options within households should be considered, including provision of separate bins. Waste management should be the responsibility of all on Ascension and would help to reduce the wider issue with rats, mice and myna who feed heavily at the waste site, as well as reduce the poor feeding habits of the feral donkeys seen feeding on waste and becoming entangled in metal rubbish.

It is essential that waste management practices at the landfill site change prior to any eradication attempt. It is currently the highest risk to the feasibility of controlling or eradicating rats, mice and myna. All waste that cannot be recycled, particularly food waste, needs to be incinerated on a nightly basis, with the incinerator routinely washed and kept free from debris. The current land fill site needs to be filled in and gate shut to keep out livestock.

Avian Influenza

Highly Pathogenic Avian influenza (HPAI) is a highly infectious viral disease that affects birds, with evidence that it can also transmit to mammals including humans (Oliver et al. 2022). Although the virus is currently not present on Ascension (L. Shearer, AIG Conservation, pers. comm.), precautions must be taken to ensure that it does not reach Ascension as the virus could be catastrophic to Ascension's seabird colonies.

Example Timeline for an Eradication

Year 1

- Public consultation.
- Produce detailed plans and proposals (Operational Plan, Communication Strategy, H&S Plan, Biosecurity Plan, etc.).
- Conduct field trials and assessments.
- Identify funding options and submit applications.
- Improve current pest management strategy.
- Pre-eradication key species monitoring.
- Procurement of equipment
- Ongoing integrated pest management strategy

Year 2

- Ongoing public consultation.
- Finalise plan, team size, and accommodation options.
- Begin procurement process for accommodation.
- Procurement of helicopter.
- Procurement of vessel (for accommodation if needed)
- Increase capacity and skill of staff and interns.
- Operational review, and equipment procurement.
- Facilitate research projects to inform future management plans.
- Pre-eradication key species monitoring ongoing.
- Ongoing integrated pest management strategy.
- Biosecurity protocols implemented.

Year 3

- Ongoing public consultation.
- **ERADICATION BEGINS.**
- Aerial baiting (2-months)
- Ground-based baiting (3-months)
- Eradication monitoring (4-months)
- Targeting any surviving invasive species detected.
- Ongoing biosecurity.
- Key species monitoring ongoing.
- Contingency plan (for 2nd year if required).

Year 4

- Ongoing public consultation.
- Contingency Year (if required).
- Ongoing biosecurity.
- Key species monitoring ongoing.

Year 5

- Eradication ends.
- Ongoing biosecurity.
- Post –eradication key species monitoring ongoing.
- Dissemination of eradication results.

Ongoing

- Ongoing biosecurity.
- Ongoing key species monitoring.

PHASE 1 : PREPARATION & PLANNING

PHASE 2: ERADICATION

PHASE 3: BIOSECURITY

ONGOING: FUNDING APPLICATIONS, COMMUNITY CONSULTATION & IMPROVED PEST MANAGEMENT

Key risks to proposed eradications

1. **Significant funding will be required for any invasive species eradication to be undertaken on Ascension Island.**

2. **The current abundance of invasive weed species will impede a rodent eradication attempt as they provide abundant sources of alternative food and harbourage.**

3. **Waste management practices observed on Ascension during the site visit are a key risk for the success of a rodent eradication attempt. A commitment to improve overall waste management on Ascension is vital. A public engagement campaign is recommended to educate all residents on the importance of good recycling, waste separation and collection practices to help reduce invasive species populations on Ascension.**

4. **If not considered for eradication, feral livestock (i.e., feral donkeys and sheep) must be corralled and managed to mitigate any non-target risks associated with an eradication that uses poison (particularly if applied aerially). Management of feral livestock should be part of a wider integrated pest management strategy for Ascension.**

5. **Interference with drones and/or helicopters by birds should be assessed using trials to determine what level of risk is associated with these aerial methods prior to their implementation across Ascension.**

6. **Competition for bait among multiple species such as mice, rats, rabbits and crabs will increase the risk of target species not accessing lethal doses of toxin. Timings of baiting operations should coincide with low natural food availability, and low population numbers if possible.**

7. **Ensuring that pet owners on the island understand the risks that would be associated with any baiting operation will be key, as open laid bait increases risk to non-target species.**

8. **A commitment to ongoing biosecurity from all agencies on Ascension will be vital to maintain the successful status of an eradication project.**

9. **The impacts of any eradication on non-target and key species need to be addressed and monitoring. Pre-eradication monitoring should be undertaken to obtain baseline pre-eradication status and trend information. Historical data should be compared with current levels to determine population change over time.**

CASE STUDIES

Predator eradication projects on islands that apply aerial and/or ground-based methods are complex and challenging undertakings, especially on island with resident communities. Lessons learnt from other island eradications should be studied and where applicable used to inform decisions for any eradication attempts on Ascension.

Macquarie Island

Background

Macquarie Island is a World Heritage Site located approximately 1500km south of Tasmania, Australia. It has no resident human population besides a permanent research base. Like many other islands worldwide, invasive species arrived on the islands through human mediated introductions. Ship rats and house mice established on Macquarie in the early 1800's, and European rabbits were introduced around the 1870's (Terauds et al. 2014). All three of these species were successfully eradicated as a result of the Macquarie Island Pest Eradication Project (MIPEP) led by the Parks and Wildlife Service of Tasmania between 2011 and 2014 (Parks and Wildlife Service 2014). Macquarie is approximately 12,800 ha in size, making it the largest island to have successfully eradicated invasive ship rats, house mice and European rabbits (Springer 2018).

Macquarie supports internationally significant colonies of seabirds, penguins and seals, as well as endemic plant species such as the Macquarie cushion plant (*Azorella macquariensis*). The impacts of invasive species on Macquarie's wildlife resulted in the extinction of two bird species, the Macquarie Island parakeet (Taylor 1979) and the Macquarie Island rail. Since the eradication of house mice, ship rats and European rabbits began in 2010, Macquarie native plant and wildlife species have begun to recover (Bird et al. 2024, Shaw 2011).

Raymond et al. (2011) highlighted that the eradication of ship rats, house mice, and rabbits simultaneously would achieve the greatest conservation gains for Macquarie Island native species. They also highlighted the risk of failure associated with attempting to eradicate mice, and the subsequent spread of other non-native species that may result from the removal of these introduced predators and competitors. The same outcomes are likely if these three species are eradicated from Ascension. The benefits of eradication should be considered in light of any potential unforeseen costs.

Challenges

Any large-scale island eradication, particularly ones that implement aerial baiting methods, are at risk of causing non-target mortality. Generally, the non-target impacts of eradication are weighted against the predicted benefits to native species that result from the removal of introduced predators and competitors. On Macquarie Island, the presence of several avian scavengers such as kelp gulls, giant petrels and skuas, meant that non-target mortality of these species caused by direct or secondary poisoning were high (Springer and Carmichael 2012).

Macquarie Island

Challenges

Measures to mitigate non-target mortality were put in place, though mitigation becomes more difficult when targeting multiple pest species simultaneously, and the risk of failing to eradicate one or more of the target species increases (Springer & Carmichael 2012). Mitigation measures used included but were not limited to the release of Rabbit Haemorrhagic Disease Virus (RHDV); a dedicated carcass collection team, to reduce the availability of carcasses containing rodenticides; removal of baits adjacent to seabird nests; and the establishment of a Bird Technical Advisory Group. Once the project had successfully eradicated the target species, the recovery of native species and those that had been impacted by non-target mortality was observed.

In addition to non-target impacts, the MIPEP faced challenges associated with weather/climate and logistical issues, which cause an initial eradication attempt in 2010 to be abandoned when delays and poor weather forecasts reduced the operational window and threatened the success of any aerial baiting operation (Springer & Carmichael 2012).

With climate change resulting in more unpredictable weather patterns, weather data will be a valuable asset to collect prior to any eradication project on Ascension, particularly with regards to how that impacts plant species that serve as alternative food sources and harbourage for the target species.

Costs and timescale

As with any large-scale island eradication project, they are expensive and lengthy processes. A management plan was produced in 2006 (Parks and Wildlife Service 2006) and funding for the MIPEP was secured in 2007, although the eradication didn't begin until 2011(Parks and Wildlife Service 2014). The four years prior to eradication commencement focused on trials and overcoming logistical hurdles to ensure the projects success. In total, the MIPEP took 7 years to achieve from securing the funding of $24.6 million dollars (AUS) in 2007 to completion of the eradication in 2014.

Lord Howe Island

A combined approach

Lord Howe Island is 1,455 ha World Heritage Area located 600 km east of Australia. It is a remnant volcano with steep and forested terrain over much of its land area. Much of its steep terrain is on its southern end with two peaks that rise to over 800 m, while the northern end is flatter and is home to most of the 350 permanent residents. In 2019, the Lord Howe Island Rodent Eradication Project (LHIREP) successfully eradicated ship rats and house mice from the island using a combination of aerial and ground-based methods (Harper et al. 2020).

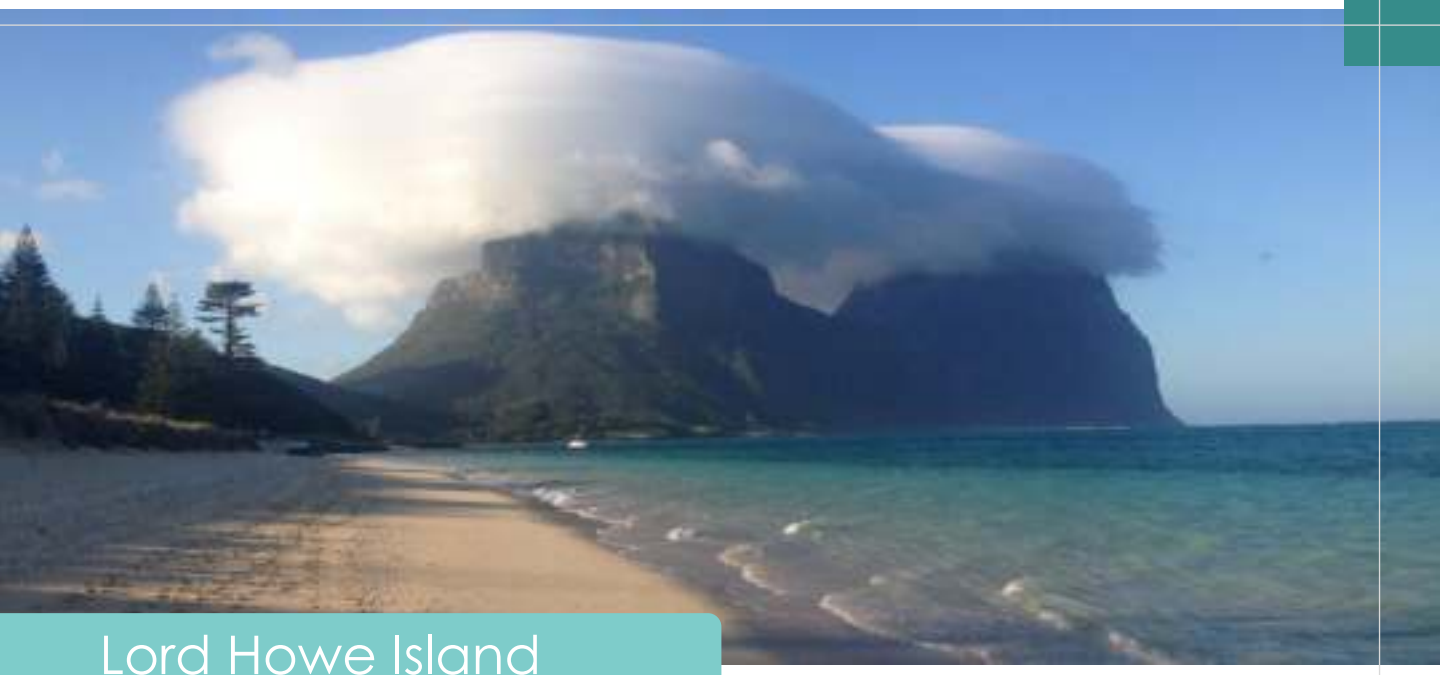
Most of the ground-based methods used on the LHIREP were applied around buildings, where aerial distribution of bait was not permitted. Where consents were obtained from residents, bait was aerially distributed 30 m from the building, whereas where consent was not given, this application was 150 m from the building. This therefore directly influenced the extent of the ground-baiting requirements for this project. Due to some opposition to the aerial application of bait, it was decided that a 10 m x 10 m grid would be used around all areas of human habitation. In total, the ground-based aspect of the LHIREP covered an area of 300 ha. The bait station grid included the placement of 667 stations inside structures. A total of 22,465 bait stations were deployed and were serviced by a team of roughly 60 field staff. Stations were serviced every 8-12 days.

Challenges

Several challenges were faced by the project, resulting from opposition to the project within the community, the presence of livestock, and the need to improve waste management practices on the island.

Specific approaches were needed for different landowners to suit their requirements and improve community relations. A team of community engagement officers were employed to help build these relationship and manage the field team with respect to accessing property, ensuring that individual landowner requirements were adhered to.

To mitigate the risks associated with livestock interfering with bait stations, handmade covers had to be constructed. The risks associated with livestock interference is greater than that expected for Ascension, as no livestock is farmed on Ascension, and only roams as feral herds.



Lord Howe Island

Learnings

Following the completion of the LHIEP, Harper et al. (2020) offer a number of recommendations for future island eradications to consider. These are:

1. Remove all bait stations at least 18 months prior to an eradication attempt.

This recommendation is given to reduce the risk of a learned aversion to bait stations developing amongst the rodent populations present. This would have to be a decision made once an eradication was confirmed to take place and would fall into the preparation phase of an eradication. Though hand-broadcast of bait would be the preferred approach on the ground on Ascension, some areas such as near buildings or other high foot-traffic areas would still require high numbers of bait stations. Community consultation would have to be upheld throughout this process to address any concerns that may be had if rodent control stopped on the island. The aim is to increase the chances of rats consuming lethal doses of bait within the smallest possible operational window, to maximise eradication success. Alternative control methods could be used in the interim to satisfy any community members with ongoing rodent issues.

2. Stop using all rodenticides on the island, at least 12 months prior to eradication.

This would be hard to enforce on Ascension as the community is impacted heavily by the presence of rodents and would possibly oppose a decision such as this. Alternative strategies to baiting could be recommended such as increased trapping efforts, or the use of other alternative control tools such as self-resetting traps (A24's) or immunocontraceptive vaccines.

3. Only apply bait externally via aerial bait application methods. Apply bait inside properties using open trays and not bait stations.

This recommendation is offered to further reduce any possible aversion to bait stations that may be present amongst a rodent population. Extending the aerial application of bait to all external areas would reduce the ground-based requirement, and using open trays inside buildings would further reduce any risk of learned aversion to more traditional bait station designs that require rats to enter them.

These recommendations are given as best-case scenarios, where opposition to these techniques would not be encountered, and that risks to non-target species would be negligible. On Ascension, openly presenting bait inside buildings would likely be opposed by the community, and risks to children and pets would need to be considered.

Gough Island

Monitoring aerial operations

Gough Island (7,803 ha) is a UKOT situated in the South Atlantic. It is a volcanic island that is a part of the Tristan Da Cunha island group, situated roughly 2,700km west of South Africa. It was the location of an attempted house mouse eradication in 2021 that subsequently failed (Samaniego et al. 2022; Samaniego et al. 2023).

The Gough Island Restoration Programme (GIRP) was attempted using aerial baiting as the sole means of applying bait. The island is uninhabited, except for a research base, which makes aerial baiting the entire island more feasible and cost-effective. Aerial baiting was conducted on three separate occasions; drops one and two being planned, with a third contingency bait drop conducted when mice were still detected in some areas of the island.

Bait monitoring conducted during the aerial operation allowed staff to monitor the degradation of bait on the ground, and better understand how this related to bait availability for mice on Gough. It was observed that bait degraded far quicker in the lowland areas of the island compared to the highland areas, with bait taking 17 and 97 days to degrade respectively (Samaniego et al. 2023). The reason for this decreased availability of bait for mice was attributed to slugs (Samaniego et al. 2022).

Monitoring of the aerial baiting operation is an important part of an eradication campaign and should be factored into any eradication plan. Team members present in the helicopter during bait application can support the helicopter pilot and advise on the bait application process and ensure that bait is evenly applied across the landscape, especially where there is a requirement for overlap between baiting sessions (i.e., where bait runs out and must be started again with a new load). Extending this monitoring to a ground-based team who can collect data for the bait on the ground can identify any issues early in the operation and allow for project plans to be adapted. Issues that may arise on Ascension include the presence of crabs and the impacts they will have on bait availability for the target species, as well as the presence of large seabird colonies that may impact upon helicopter flight paths and therefore bait coverage.

It is recommended that an aerial operation factors this requirement into any team size estimates, to ensure effective monitoring of the operation.

The Isles of Scilly

Background

The Isles of Scilly (IOS) are an island group in England located 45 km southwest from Lands End. They are nationally and internationally important for wildlife, home to 16,000 breeding seabirds of 13 different species (Heaney & Pierre 2015) plus a diverse range of other flora and fauna. In recognition of their value for seabirds, the IOS are a designated Special Protection Area, part of the European-wide network of key wildlife sites. Two of the key species that breed on the IOS are the Manx shearwater (*Puffinus puffinus*), and European storm petrel (*Hydrobates pelagicus*). Both species are amber listed under the UK Birds of Conservation Concern threat ranking. In England, storm petrels breed only on the IOS, and Manx shearwater breed on both the IOS and on Lundy Island in the Bristol Channel. Manx shearwaters and storm petrels are susceptible to predation from introduced predators such as brown rats.

In 2009 the islands of St Agnes and Gugh were chosen as a suitable site for brown rat eradication, and the Isles of Scilly Seabird Recovery Project (IOSSRP) was formed. The islands were chosen for three key reasons:

1. Removing rats from St Agnes and Gugh protects the island of Annet, the location of England's only breeding storm petrel colony, and an internationally important island for seabirds.
2. St Agnes and Gugh are separated from the rest of the archipelago by a deep, tidal channel that is at the limit of brown rat swimming distance, making them unlikely to be reinvaded by rats.
3. Manx shearwaters are already present on the St Agnes and Gugh with more suitable habitat available, providing the potential for population recovery.

The Isles of Scilly

Community Engagement

St Agnes and Gugh are the smallest inhabited islands in the archipelago with a population of roughly 85 residents. Gaining 100% support from the community was crucial for a successful outcome for the IOSSRP and its rat-free legacy.

In the project development phase, all island residents were interviewed in person. They were asked what their level of support would be for the removal of rats, what concerns or stipulations they had, what benefits they would expect and what would motivate them to keep the islands rat-free. All residents valued seabirds and agreed that the removal of rats would also benefit the inhabitants.

Questionnaires completed by island residents revealed that damage caused by rats was estimated to cost between £10 and £1000 per household per year, due to purchasing bait, loss of crops, loss of stock feed, and damage. Therefore, rats were costing the St Agnes and Gugh community approximately £15,000 per year. Regarding health and enjoyment, up to 80% felt that the removal of rats would deliver health benefits.

Getting rat-removal ready

All residents were provided with information on how to get the island “rat removal ready“. Workshops aimed to inform residents how to reduce the food and harbourage available for rats were held. The project team helped residents to clear sheds and build compost bins. A community bonfire was held as an opportunity to remove burnable waste and celebrate the start of the project.

The risks to non-target species including pets was explained to all residents, including how measures would be taken to reduce the likelihood of access to bait and an antidote treatment (Vitamin K1) would be available.

The community ceased baiting for a year prior to the baiting operation to ensure rats were not overly exposed to bait, and instead used the snap traps supplied by the project. On farms, livestock pens were adapted to ensure full bait station coverage was achieved safely, and that access for rats to livestock feed and bedding was reduced.

The highest risk biosecurity pathway to St Agnes and Gugh is via boats, so advice was given to residents and the ‘Harbour Users Group’ regarding vigilance and reduction in high-risk freight items.

Image credit – Alastair Wilson

Isles of Scilly

Legacy phase

The ground-based eradication was successfully completed between November 2013 and March 2014, during which all brown rats were successfully removed. The project now had to ensure its success and so continued monitoring for rats and training the community to take on the responsibility of ensuring the islands remained rat-free.

Community champions were appointed to help train and inspire both the local community and visitors to the island to ensure that all steps were taken to reduce the risk of rats reinvading the islands. Two years after the eradication had been completed, an intensive final check was carried out to confirm the success of the project.

All throughout this process, the community were involved and brought along via events such as workshops, pub quizzes and community events. Now, new businesses have established because increased tourism to the islands resulting from the success of the project.

Members of the St Agnes and Gugh community now lend their knowledge to other community projects, to further help native species that are threatened by invasive predators.

RECOMMENDATIONS

HIGH PRIORITY

WMIL recommends that:

1. An intensive rodent control programme is designed and implemented to increase rodent control on Ascension until an island-wide eradication can be implemented. This control programme should utilise all suitable control methodology and tools, including new devices and other products. WMIL would be able to prepare this for the Ascension Island Government.
2. Brodifacoum and flocoumafen are no longer used for ongoing rodent control.
3. Permanent baiting for rodents is restricted to key areas, and the remainder of the island operates under a pulsed baiting regime.
4. Bromadiolone or difenacoum are used in pulsed operations every three months, or before the breeding season for key species (i.e., seabirds or turtles) begins.
5. The Environment Health team undertake bespoke rodent control training covering best practice methodology, rodenticide handling, rodent monitoring and data collection and analysis. WMIL would be able to prepare this for the Ascension Island Government.
6. Environmental Health capacity is increased by the employment of two new staff and that these new personnel focus their efforts on rodent control.
7. Waste management on Ascension is improved, especially using the incinerator to dispose of food waste and repairing the fence around the landfill and ensuring the gates are closed overnight to exclude donkeys and sheep.
8. The Ascension Island Government look into funding options for invasive species eradications, particularly an island-wide rat eradication.
9. A detailed construction and project plan should be developed for a predator-exclusion to protect sooty terns at Mars Bay and seabirds at Letterbox National Park. WMIL would be able to prepare this for the Ascension Island Government.
10. A detailed biosecurity plan is produced for Ascension, covering all invasive species and outlining risks, pathways, prevention, detection and incursion response.

RECOMMENDATIONS

MEDIUM PRIORITY

WMIL recommends that:

1. The Ascension Island Government work with experienced helicopter pilots to determine practicality of operating helicopter around the seabird colonies. Risks and mitigation for any risks should be outlined.
2. The Ascension Island Government work with experienced rope access technicians to determine the practicality of rope access in no-fly zones (e.g., Letterbox Nature Reserve). This should include a geology assessment to determine suitability of the rope for rope access anchoring.
3. Baseline key species monitoring is conducted across a range of habitats on Ascension.
4. There is coordination between all parties on Ascension to use the same toxin across the island to prevent bait aversion and resistance developing.
5. Community consultation regarding all possible invasive species eradication is begun to explain eradication requirements and gather information on opinions about invasive species and concerns about future operations.
6. Invasive plant management is maintained across Ascension.
7. An eradication operation to target rabbits on Ascension is investigated while rabbit numbers are low.
8. Invasive species monitoring is undertaken using a range of tools including trail cameras to obtain behavioral information, population abundance and density estimates across the island over time.
9. Bait stations along all paths on Green Mountain are checked, with all damaged or unsecured bait stations replaced with new and secured in position.
10. Rainfall monitoring stations are established to better predict where rodent populations may increase in response to higher natural food availability (vegetation growth) and allow focused baiting effort to be completed to respond to these rodent irruptions.
11. Self-resetting traps are tested on Ascension to see if they could be implemented as part of the overall pest management strategy.
12. Investigate the legal requirements to approve aerial bait deployment (by helicopter and/or drones).
13. Investigate the legal requirements to approve the use of toxic baits to target rabbits.
14. Given the requirements for accommodation and infrastructure (storage of equipment, bait and office facilities) for any eradication, identify property on Ascension that could be restored to be used in a future eradication operation.

LOW PRIORITY

WMIL recommends that:

1. A “hotline” for community to report dead pests (roadkill or found on surface) is established.
2. Feral sheep and donkeys are contained in a management site to reduce their impact on the natural biodiversity of Ascension, reduce invasive plant spread, and improve their welfare.
3. The feral donkeys are sterilised and allowed to slowly die out on Ascension.
4. Myna traps are purchased for use on Ascension, and a low level of control is implemented.
5. EH staff use a Bait Station Servicing and Data Collection SOP for all their rodent control.
6. Immunocontraceptive options are trialled at key sites (i.e., landfill) to determine viability for rodent control.
7. Detailed habitat maps are produced.
8. Collate existing information on invasive species into one in-depth formal report.
9. Investigate the availability of suitable vessels for aircraft transport and housing eradication personnel in the event of an eradication.

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APPENDICES

Appendix No.	Content
1	Glossary
2	Objectives and Outcomes
3	Ship Rat Field Sign
4	House Mouse Field Sign
5	Seabirds
6	Rat Morphometric Data
7	Non-Target Species
8	The 7 Feasibility Criteria
9	Bait Options
10	Example Standard Operating Procedure
11	Eradication Tools
12	Example Bait Grid

APPENDIX 1

Glossary

Term		Definition
Eradication		Remove the entire population from an area, with either no immediate risk of re-invasion or biosecurity measures to prevent or respond to incursions.
Feasibility Criteria	Technical	Is the project technically feasible with the chosen methods and resources? Do we have the tools and knowledge to achieve elimination?
	Sustainable	Is the outcome of an elimination sustainable? Can invasive pest species be kept out of the project area, and are these methods in themselves sustainable?
	Political & Legal	Does the project meet the political and legal requirements, including permits, licenses, animal welfare/ethics standards, and is supporting by local and national policy?
	Social	Are the aims of the project supported by people involved? Who are the communities, shareholders or landowners who we need support from?
	Environmental	What are the environmental impacts associated with the project, and how are these to be mitigated (e.g., rodenticide use, risks to non-target species, alternative food sources, H&S, waste management)?
	Capacity	Does the project have the capacity to carry out the elimination? What team size, structure and resourcing will be required?
	Financial	Does the project have, or will it be able to secure, sufficient funding to see the elimination through to the end? Is there sufficient contingency funding to cope with changing project requirements?
Legacy		A projects legacy is the long-term future of the project, its community, and the benefits for species that are the aims of the project such as long-term population growth or recovery.
Microhabitat		A microhabitat is used to describe a small pocket of high-quality habitat, that is often unique to the surrounding habitat. Examples include dense patches of weed plants in otherwise open/native areas of bush; rubbish piles; compost heaps/bins.
Immunocontraceptive		A substance introduced to a target species that attacks the proteins associated with reproductive cell development. It will result in an immune response within the individual that attacks its own reproductive cells, causing infertility.

APPENDIX 2

Objectives and Outcomes

Table 2: *The objectives and outcomes for the removal of invasive pest species from Ascension Island.*

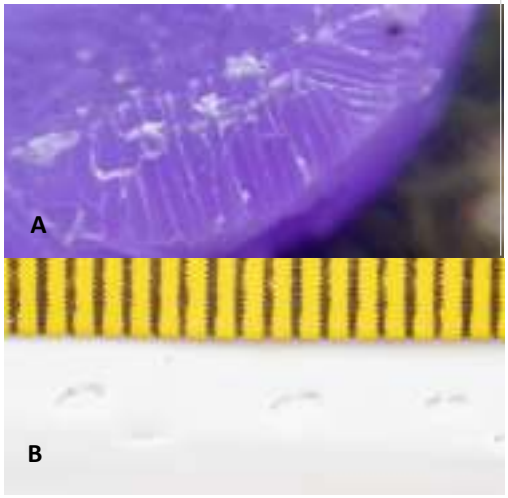
Objective	Outcome
1. That the invasive species targeted area are successfully eradicated from Ascension.	i. No individuals of the targeted invasive species remain on Ascension Island. ii. Increased native vegetation cover on Ascension Island. iii. Increased abundance and diversity of key native species on Ascension Island.
2. Biosecurity measures are installed on the island to prevent re-establishment of the eradicated invasive species.	i. Robust biosecurity strategy implemented on Ascension Island. ii. Permanent monitoring stations installed on Ascension Island. iii. Routine monitoring checks scheduled and completed. iv. Invasive species free status of Ascension Island (i.e. “rat-free”). v. Collaboration with St Helena and the Falkland Islands to improve biosecurity in the mid-Atlantic region.
3. Biodiversity is monitored to measure any change in native species following the invasive species eradication.	i. Native fauna and flora species abundances increase on Ascension Island. ii. Document evidence of benefits of invasive species eradication to support ongoing efforts to eradicate or control invasive alien species in the region.
4. Training is provided to Ascension Island Government staff and volunteers to increase capacity within Ascension Island to address threats from invasive species on the island.	i. Increased capacity within the Ascension Island Government to maintain outcomes for points 1, 2 and 3. ii. Increased opportunity for Ascension Island Government staff to educate other organisations/agencies/people about the importance of island eradications. iii. Increased competency for staff to recognise and respond to invasive alien species incursions.

APPENDIX 3

Ship Rat Field Sign

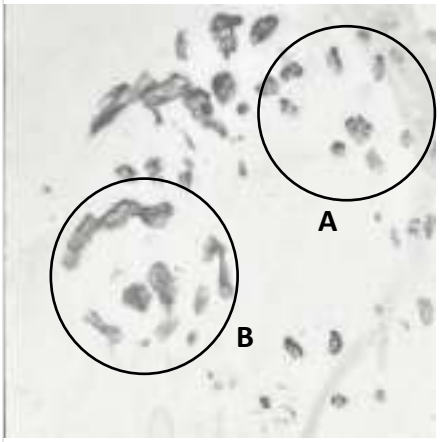
Droppings

Between 6mm and 14mm long.
Roughly 3-5mm wide.
Rounded or pointed ends.
Usually contain hair, seeds/vegetation and insects.



Chew Marks

Gnaw marks leave parallel lines (A)
Leave tell-tale M-shaped incisor marks (B)



Footprints

Forefoot has 4 toes and 3 main pads (A)

Hindfoot has 5 toes with a split central pad (B)

Ship rat forefeet are about 13mm wide and 12mm long, and hindfeet are about 18mm wide by 16mm long

Image credit – Jenny Daltry/FFI

APPENDIX 4

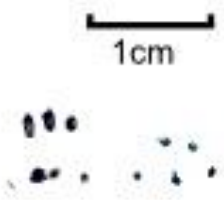
House Mice Field Sign

Droppings

Usually shorter than 1cm long, and thinner than 3mm wide. Rounded or pointed ends. Usually contain hair, seeds/vegetation and insects.

Chew Marks

House mice leave quite neat and rounded appearances to bait blocks. Their gnaw marks are 1mm wide in total (0.5mm wide per tooth)



Footprints

Forefoot (right) has 4 toes arranged in a circular pattern around the central pad.

Hindfoot (left) has 5 toes (3 positioned forward, two at the sides) with a split central pad.

House mouse feet are about 8mm wide with toe prints ~1mm in size.

APPENDIX 5

Seabirds

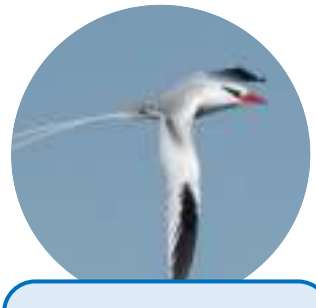
Ascension Island Frigatebird
Fregata aquila

Masked Booby
Sula dactylatra

Brown Booby
Sula leucogaster

Red-footed Booby
Sula sula

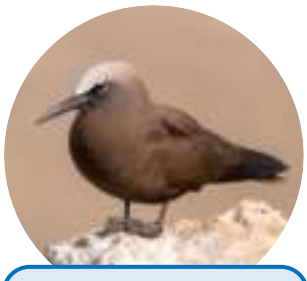
White-tailed (or Yellow-billed) Tropicbird
Phaethon lepturus



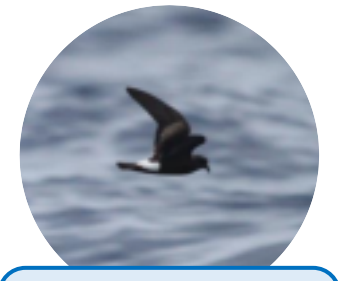
Red-billed Tropicbird
Phaeton aethereus

Sooty Tern
Onchyprion fuscata

Fairy Tern
Gygis alba



Black Noddy
Anous minutus



Band-rumped Storm Petrel
Hydrobates castro

Red-billed tropicbird: © Christoph Moning

APPENDIX 6

Rat Morphometrics

Table 3: *Rat morphometric and dissection data collected during the feasibility site visit.*

APPENDIX 7

Non-Target Species

Humans

There is a resident population of roughly 800 people on Ascension that live predominantly in four settlements; Georgetown, Two Boats Village, Travelers Hill, and the US Military Base. Any baiting operation undertaken in these areas will be done so using secure and lockable bait stations that only project personnel can access. There is a higher risk to children who may be inquisitive and pick up baits on the ground or inspect bait stations. It is therefore important that the project engages with the community through consultation processes and increased education about any such project. As with domestic pets, an antidote (vitamin k1) must be kept on island during any project that uses anticoagulant toxins. As settlements should be baited using lockable and secure bait stations, the risk to humans is generally considered low.

Birds

Occasional vagrant birds such as raptors, skuas and gulls have been recorded on Ascension (Lepage 2024). If any of these species are present on Ascension during a baiting operation, risks to these species are likely to be high due to their tendency to scavenge on carcasses. They are at most risk from secondary poisoning from second generation anticoagulant rodenticides (SGARs) such as brodifacoum (Ebbert et al. 2010, Howald et al. 1999, Thomas et al. 2011), and are commonly exposed to SGARs through scavenging poisoned rat carcasses associated with rodent control operations (Nakayama et al. 2019).

Species recorded on Ascension as vagrant individuals include kelp gull (*Larus dominicanus*), red-footed falcon (*Falco vespertinus*), south polar skua (*Stercorarius maccormicki*), and black kite (*Milvus migrans*). As these species are not resident on Ascension any baiting operation is not considered a high risk.

In all instances, searches for carcasses should be conducted to collect and remove any rodent carcasses found on the surface. Any carcasses that are found should be correctly disposed of via incineration.

Although passerines have been known to eat rodenticide bait (E. Marshall, WMIL, pers. obs.), the bait formulation and colour can be selected to reduce this risk. Blue dye results in the greatest aversion to baits from birds, followed by green while red and yellow baits were found to be more attractive to a New Zealand passerine species (Hartley et al. 1999). Waxy bait can further reduce interaction with non-target bird species (Varnham 2003). Bait trials should be run prior to an eradication operation to determine the level of bird interaction with coloured bait and bait stations.

The greatest risk to bird species is through secondary poisoning by consuming animals that have fed directly on bait.

Additionally, there is a risk of disturbance arising from the work itself impacting upon birds present on Ascension. The baiting operation could be timed to take place outside of the breeding season for species considered most at risk of disturbance, though as at least some seabird species will be breeding at any point throughout the year due to sub-annual breeding cycles (Reynolds et al. 2014), some risk should be expected. During the feasibility site assessment frigatebirds were observed to show an interest in drones (E. Marshall. WMIL, pers. obs.). It is recommended that prior consultation with helicopter pilots is undertaken to ensure that the frigates do not show the same interest in helicopters which could lead to bird strike.

Domestic cats and dogs

Although domestic cats are unlikely to show interest in bait itself, they are at high risk of succumbing to secondary poisoning by consuming rodents that have fed directly on bait. It is advised that all pet cats are kept indoors or contained in a cat enclosure or “catio” during the eradication phase of the operation to reduce this risk.

Unlike cats, domestic dogs will show an interest in consuming bait if they can access it. They are also susceptible to secondary poisoning by consuming rodents that have fed directly on the bait. To protect pet dogs, all baiting near properties would need to be contained within lockable bait stations. It is also advised that dogs are not walked in areas where bait has been applied aerially during the eradication phase as there is a chance they could consume bait and dead or dying rodents.

APPENDIX 7

Non-Target Species

Domestic cats and dogs

Warning signs would need to be placed at the start of every trail prior to any baits being laid, with many walking tracks being closed completely. Safe areas to walk dogs on leads could be established if the community want it but would increase the requirement for ground-baiting using lockable stations to be used.

Prior to the commencement of any eradication operations a thorough consultation period must be undertaken to ensure community members are aware of the risks posed to their pets. However, it is also worth noting that anticoagulant rodenticides are currently widespread on Ascension and the associated risks are already present to some level.

If a domestic animal consumes anticoagulant bait or is suspected to have anticoagulant poisoning, they can be treated with the antidote vitamin k1, which can be administered either as a tablet or an injection by a qualified veterinary practitioner. As there are currently no qualified veterinarians on Ascension it is recommended that a vet joins the project staff for the duration of the eradication period.

Livestock

Feral donkeys and feral sheep are present on Ascension. Consultation with community members highlighted that many consider the feral sheep to be pests, responsible for road traffic accidents, property damage and the spread of non-native plant species. Feral donkeys were largely seen as a part of Ascension, and not something people wanted to see removed.

Free roaming stock would need to be managed throughout the eradication as they are at risk of consuming rodenticides and can interfere with bait stations and monitoring tools. Currently donkeys are not managed. There is anecdotal evidence that sheep are shot for meat, though this is infrequent. Many animals were seen to be in poor condition, often seen feeding on waste from the landfill site and becoming injured through entanglement with waste materials (L. Titterton, WMIL, pers. obs.). Prior to any eradication operation, community consultation must be undertaken to find a solution for these animals, whether that is to remove them from Ascension or corral and manage them in a secure area.

Should the community opt to corral the donkeys and sheep, the enclosures would need to provide enough space per animal plus access to fresh water, food, and shade. Welfare and herd dynamics will also need to be considered. Male donkeys (stallions) become territorial during the breeding season causing fights and potentially fatal injuries within the herd and presenting a danger to any handlers. It is therefore recommended that male donkeys are castrated to prevent disputes and breeding.

Prior to rounding up, a decision would need to be made on if the stock should be released again after the operation, taking into consideration that their current role in the environment encourages the spread of invasive plants and their poor current welfare standard. WMIL recommend that if livestock are contained and managed during an eradication, that they remain contained and managed after any such project. WMIL would not recommend the release of these animals once corralled.

Marine environment

The marine environment surrounding Ascension is an MPA and requires special effort to avoid contaminating it with toxins. Small-scale fishing operations are permitted within 12 nautical miles of the coast, and as such any contamination of marine life with toxins used would impact upon the local community.

The risk to marine life from any baiting operation is considered low. An accidental spill of ~20 tonnes of brodifacoum into the sea near Kaikoura, New Zealand, provides valuable data regarding persistence of brodifacoum in the marine environment when large quantities of rodenticide enter the marine environment (Primus et al. 2015). It was found that the resulting contamination was localised to an approximately 100m2 area, and that brodifacoum residues declined below detectable levels in the water and sediment at 3 and 9 days respectively. They found the longest persistence of brodifacoum resides were found in shellfish such as mussels, which still had detectable levels of brodifacoum after 31 months. This is obviously an exceptional occurrence, and bait contamination into the marine environment from any typical eradication operation is not expected to reach these levels.

APPENDIX 7

Non-Target Species

Marine environment

A review of the information available on the use of brodifacoum (Broome et al. 2015) states that 133 samples of marine fauna were collected after eight eradication projects in New Zealand, and only six samples had detectable levels of brodifacoum present. They go on to say that "*from the highest of these residues (0.022 ppm) it is calculated that someone would need to eat around 700 kg to reach the human LD50 dose or nearly 3 kg even to reach the NOEL (no observable effects limit)*".

Land crabs

While crabs will readily feed on bait containing rodenticide, they are not readily affected by it and, in the case of brodifacoum, showed no detectable levels one month after bait application ending (Pain et al. 2000).

The greatest risk associated with crabs consuming rodenticide bait or poisoned carcasses results from human consumption of affected crab meat. The land crabs on Ascension are protected and so no such consumption is expected. Regardless, during any baiting operation it should be emphasised that land crabs should not be consumed.

Due to land crabs' high consumption of rodenticide baits they can affect the bait availability for rodents during eradication operations (Bell et al. 2017, Griffiths et al. 2011) and as a result, are a key cause of rodent eradication failure (Samaniego-Herrera et al. 2019). Recommendations to mitigate this risk of project failure include increased bait application rates (Griffiths et al. 2011).

Plants and fungi

The primary risk to plants and fungi on Ascension is through trampling associated with any groundwork required as part of an island wide eradication operation. Key plant species should be made known to the field teams involved with work on island to avoid risks of cutting or trampling. During the feasibility site assessment rats were observed through stomach contents analysis to be feeding on non-native Mexican thorn and guava. The extensive spread of both these weed species provides an alternative food source for rodents and therefore managing the spread of these populations is recommended before attempting eradication.

The removal or control of invasive grazing species such as feral sheep and feral donkeys may result in an increase in plant species that were previously maintained at low levels by donkeys and sheep. This will likely include invasive weed species, that will begin to compete with native species for space and resources. A weed species control programme should be incorporated into any ongoing plans, to monitor the impact that these may have on the regeneration of native plant communities.

APPENDIX 7

Non-Target Species

Table 4. *A breakdown of the non-target species/groups that may be impacted by an eradication operation on Ascension Island, and the associated risks of each species/group.*

Group	Effect	Preventative Action	Risk
Humans	Direct Poisoning Secondary Poisoning	Education. Lockable bait stations used in and around any areas of human habitation. Bait wired into bait stations near properties and in townships. Vitamin K1 antidote. No-take policy for land crabs emphasised.	Low
Domestic Cats and Dogs	Direct Poisoning Secondary Poisoning	Carcasses collected. Bait wired into bait stations near properties and in townships. Cats kept indoors for the duration of the eradication. Dogs walked on leash is safe areas only. Community education Vitamin K1 antidote.	High for cats Medium for dogs
Feral Livestock (if not targeted for eradication)	Direct Poisoning Secondary Poisoning	Either: Remove feral livestock from Ascension completely prior to the eradication operation. Or: Corral sheep and donkeys in a designated safe pasture.	Medium
Birds	Direct Poisoning Secondary poisoning Disturbance Avian Influenza	Carcasses collected. Bait formulation. Timing of eradication. Minimise activity in breeding areas. Screening, cleaning and quarantine on arrival for staff and equipment	Low
Marine Life	Direct poisoning. Secondary poisoning	Care to prevent bait falling into sea. Bait wired in position. Carcasses collected.	Low
Crabs and other invertebrates	Direct poisoning. Secondary poisoning by eating carcasses.	Bait does not affect invertebrates. Bait placement (i.e., off the ground, moved if interference noted, etc.). Bait wired in position. Bait formulation.	Low
Plants and fungi	Trampling by field workers. Risk of alien plant species being introduced with soiled equipment.	Identify and map locations of rare plants. Screening, cleaning and quarantine on arrival for staff and equipment	Low

APPENDIX 8

The 7 feasibility criteria

A feasibility study is assessed against these seven criteria. To be considered feasible, the project must meet each criteria:

1. Technical feasibility
2. Sustainability
3. Political & Legal Acceptability
4. Social Acceptability
5. Environmental Acceptability
6. Capacity
7. Affordability

1. TECHNICAL FEASIBILITY

Can the technique(s) be used at the project site to remove all individuals of the target populations?

Technique(s) must meet the following conditions:

1. They must target every individual of each target species.
2. They must remove the target species faster than they can replace their numbers.

Logistical challenges such as accessing difficult terrain, or through challenging vegetation must be solvable. This could come down to obtaining access agreements, or making sure the correct equipment is available to cut access tracks.

If there are multiple target species the conditions must be met for all species, which can require adaptive approaches.

Image 1. Accessing difficult terrain is an important requirement for a successful elimination, and unique solutions are often required in each instance to suit the local habitat, species, and community considerations.

Image 2. Grid density and device placement is an important factor to consider when assessing an elimination. Can devices be installed in all locations they may be required for the target species including features such as caves, offshore stacks, and cliffs.

Image 3. Steep terrain can often pose issues to the technical feasibility of a project, as methods of working on these slopes require specialist equipment, H&S considerations and training. Geology assessments can be useful to determine whether the rock is unsuitable for anchoring rope access points.

APPENDIX 8

The 7 feasibility criteria

2. SUSTAINABILITY

Can the re-establishment of the pests be prevented?

MONITORING AND DETECTION

The ability to detect incursions is vital to preventing the re-establishment of pest species. There are several tools that can help make monitoring more effective and increase chances of detection. Trail cameras are one such example and are ideal for long-term monitoring.

RESPONDING

Once detected, a concerted effort to target the individual(s) and establish the extent of the incursion is key. This is where teams of volunteers and staff come in to coordinate an organized response that covers the key areas and habitat where invading species might establish.

An important part of an incursion response is improving understanding of microhabitats, which can involve; talking to community members to better understand habitats around buildings; using aerial imagery to determine the location and extent of habitats that may provide food and shelter for pests; or simply exploring the area by foot and identifying locations for new trap or bait station installations.

BARRIERS

They can be literal barriers such as predator-exclusion fences, or buffer zones comprised of a network of traps or bait devices and other tools that protect against pest species re-establishing.

They are used to keep predators out of an area where they have been eradicated and allow native species to recover.

APPENDIX 7

The 7 feasibility criteria

3. POLITICAL AND LEGAL ACCEPTABILITY

Can all required permits and consents be secured?

LAND ACCESS

Access to both private and public land is needed for eradications. Obtaining land access agreements with landowners is therefore a must to allow field workers to carry out their work.

TRAPPING METHODOLOGY

On Ascension, there is no legal obligation to use a trap that has passed regulatory tests, but any pest control conducted by the Ascension Island Government should be aiming to set the standard with respect to the humaneness of which pest species are trapped.

BAITING METHODOLOGY

All toxins used on Ascension Island must be approved by the UK government, but other factors relating to social acceptability should also be considered.

NAWAC
National Animal Welfare Advisory Committee

HM Government

APPENDIX 8

The 7 feasibility criteria

4. SOCIAL ACCEPTABILITY

Does the project have full support from the community?

For any pest control project to succeed, the support from the community involved is crucial as this will help to secure the legacy of the project. This means that ongoing efforts to engage with the community need to happen, to take on board the opinions, and concerns they will have. This provides the community with a chance to make sure everyone can have a voice in the project and enhances the projects legacy.

What is the risk to children and pets?

With an aerial operation, bait will be present on the ground outside of bait stations. As such, education will be paramount to ensure that children as well as adults are aware of the risks and avoid handling bait. Where people want bait stations around their properties, these will be made available. Carcasses of poisoned animals may sometimes be found on the surface, and the risk associated with these should be communicated clearly, with clear steps for people to follow if they encounter one.

What access is required and what will I have to do?

Communication with the community about the importance of access, and the need to work together to minimize any impacts on property, should provide solutions to challenges unique to different people and locations.

APPENDIX 8
The 7 feasibility criteria

5. ENVIRONMENTAL ACCEPTABILITY
Can the impact on the environment be managed or minimised?

Carbon Impact

Considerations should be given to the carbon footprint associated with the project and ways in which it can be offset or reduced.

Trucks will be necessary to overcome some of the logistical challenges such as transporting equipment and staff to the field. Decisions will need to be made regarding how many vehicles will be required, and importantly if any of these could be electric/hybrid vehicles.

Environmental Impacts

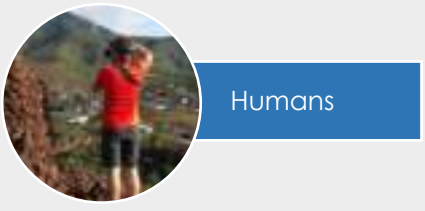
- There is a risk that downdrafts from helicopter engines can dislodge loose soil and rocks which may result in landslips. Input from experienced pilots can help to avoid this risk.

- There are no sources of fresh water on Ascension, though there are several water catchments. Baiting should be closely managed around these to mitigate risks of contamination.

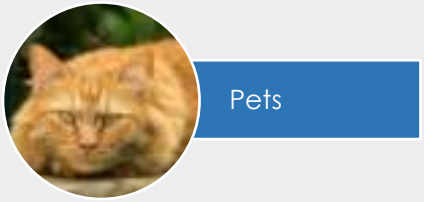
- It will be the responsibility of everyone on the team to manage the disturbance they cause as they work across Ascension. Distress to species as well as damage caused by footfall should be closely monitored, and steps to reduce this taken if deemed necessary.

Non-Target Species

- Bird strike is a risk with any aerial operation where seabird colonies are present. Spotters and experienced pilots will be able to better assess the risks posed on Ascension.



- Humans should be educated about the risks an eradication pose.



- Cats should be kept indoors, and dogs should not be walked off a lead, due to the risks associated with bait on the ground.

APPENDIX 8
The 7 feasibility criteria

6. CAPACITY
Can the required skilled people, resources and equipment be found and acquired?

There is unlikely to be a large enough existing pool of people who would be able to work on an eradication project already living on Ascension, though where possible opportunities for work should be offered to local community members. Due to the specialist requirements associated with the work such as qualifications to handle toxins, experience conducting eradications, and the physical capabilities to work outdoors for full days, it is expected that the majority of team members would have to be employed and relocated onto Ascension for the duration of the eradication. This would require that sufficient accommodation was available on Ascension to house all team members.

There is a growing number of people with eradication experience, and it is expected that the team would comprise mainly of individuals with this experience.






APPENDIX 8

The 7 feasibility criteria

7. AFFORDABILITY

Can it be demonstrated to funders that the benefits of the project outweigh the costs?

Ascension Island has a history with non-native species removal, thanks to the successful eradication of feral cats that took place between 2001-2004. The results of this successful eradication are already evident, with many of Ascension native seabird species now established on the main island on the Letterbox Nature Reserve. Because of this, there is existing evidence that the removal of invasive species can yield significant conservation benefits on the island. Existing research shows that rats are currently limiting the further recovery of these species and provide further support that investment in an eradication will result in further conservation gains.

The financial cost of eradicating species from Ascension is high, and depending on the species targeted would be in excess of £40 million to achieve. Funding will likely be required from philanthropic sources, or, if possible, from substantial government funding.

APPENDIX 9

Bait Options

Bait	Pros	Cons	Outcome
Bromadiolone	Moderate potency Single feed Delayed onset of symptoms Effective on rats (*Rattus norvegicus* in particular) Antidote available Not readily soluble in water Binds strongly to soil and released slowly to the water environment. Previously successfully used in eradications	Persistence issues (> 9 months in some species) High secondary poisoning risks Less potent than brodifacoum Some resistance issues suspected Limited data on non-target impacts	**RECOMMENDED**
Diphacinone	Low potency. Delayed onset of symptoms. Less persistent than second generation anticoagulants. Reduced secondary poisoning risk. Reduced risk of non-target poisoning. Low toxicity to raptors. Used successfully on island eradications. Cheaper than second generation anticoagulants. Antidote available.	Low potency. Multiple feed. Large quantity required. Repeated applications required. Longer access to bait required. Less persistent (metabolised quickly). Non-target impacts recorded (Dennis & Gartrell. 2015).	**RECOMMENDED (FOR CONTROL)**
1080	Naturally occurring. Biodegradable. Reduced risk of non-target poisoning if used in bait stations. Does not readily bioaccumulate.	Politically and socially contentious. Use is highly regulated and controlled. Breaks down quicker in wet conditions, which would reduce availability to target species. High risk to cats and dogs.	NOT PRACTICAL
Brodifacoum	Very potent. Single feed. Delayed onset of symptoms (i.e. prevents neophobia and bait shyness). Very effective on rodents. Insoluble in water and binds to soil (slowly degraded). Successfully used in island eradications worldwide. Efficacy and non-target species data widely available. Range of bait formulations available. Antidote available (long-term treatment required).	Persistence issues (> 9 months). High secondary poisoning risks. Non-target impacts recorded. Expensive. Not recommended for long-term applications on the mainland in NZ. Widely used in agriculture/commerce/industry (risk of learned aversion or resistance to bait). Not wanted by the community.	**RECOMMENDED (FOR ERADICATION ONLY)**
Pindone	Delayed onset of symptoms. Less persistent than second generation anticoagulants. Reduced secondary poisoning risk. Cheaper than second generation anticoagulants. Antidote available. Low solubility in water. Binds strongly to soil and breaks down slowly.	Low potency, requires multiple feed. Large quantity required. Repeated applications required. Longer access to bait required. More labour intensive (as baiting phases of operations must be longer). Weather affects bait as it's left out for longer. Less persistent (metabolised quickly). Untested for larger scale eradications. Evidence of palatability issues in rodents	NOT RECOMMENDED {EXCEPT FOR RABBIT-ONLY ERADICATION]

APPENDIX 10

Bait Station Servicing and Data Collection SOP

PERSONNEL INVOLVED

All AIG EH team members that have undergone on-site training in all requirements and techniques to handle rodenticide and record data collection for bait station servicing.

EQUIPMENT

All data for bait station servicing will be collected in the notebooks provided, which should be entered into the master datasheet at the end of the date. Required equipment is provided in Table 1. Table 2 provides an example of data collection spreadsheet that should be recorded in a field notebook.

***Table 1**. Required equipment for bait station servicing and data collection.*

Equipment	Quantity	Notes
Mobile phone	1	• For communication between team. • Should have camera to collect photos if required.
Phone case	1	• To protect phone from dust and rain.
Power bank and cable	1	• Used to charge phone if necessary
Notebook	1	• For data collection
Pencil	2	• One, plus a spare, in case it breaks or is lost.
30 cm clear plastic ruler	1	• Useful for measuring droppings, field sign and for recording morphometrics if required.
Waste bait bag	1	• To collect waste bait from stations.
Fresh bait	As required	• Ensure enough bait is being carried to service all bait stations with the required bait that day.
Ziplock bags	5	• To collect any field samples, including rat carcasses if found.
Bait station warning labels	10	• To add or replace worn warning labels.
Marker pen	1	• To write on bait station codes if required.

***Table 2**. Example of data collection spreadsheet for recording bait station service results without a phone app.*

Date	Recorders initials	Bait station code	Bait remaining	Species detected	Bait removed	Bait added	Notes
1/11/2025	*EM*	*KB01*	*0.5 blocks*	*Rat, mouse*	*0.5 blocks*	*4 blocks*	*Rat dropping present, bait station replaced*

APPENDIX 10

Bait Station Servicing and Data Collection SOP

PROCEDURE

BAIT STATION PLACEMENT AND LOCATION

Ensuring that all team members service bait stations to the same high standard is vital so that data collection is consistent, and that control is more effective. Poorly maintained bait stations can discourage rats from entering them and old or spoiled bait can prevent rats from consuming it. Upon approaching each bait station, team members should carry out the following checks, and make notes where applicable:

1. Make sure the station is in the best position for rats to enter.
    a. Placement along a run, flat surface or linear feature work best around buildings.
2. Make sure the station is stable when in position.
    a. Press down on either side, there should be no movement.
3. Make sure that both entrances are clear of vegetation, and that a rat has a clear line of sight through the station.
4. Does the station have a warning label that is easily read?
    a. Replace if not.
5. Does the station have its code easily visible on it?
    a. Replace if not.
6. Are there signs of interference with the bait station (i.e. from sheep or donkeys)?
    a. Has it been damaged in anyway? If so, can it be moved to another location nearby?
    b. Make notes of any interference.

SERVICING A BAIT STATION (BAIT CHECK)

When servicing the bait station contents, this is where data collection should begin. Accurate data collection is important for reporting purposes. The wide-scale use of rodenticide must be strictly monitored. The following steps outline the process for conducting a bait station check, and highlights what must be recorded.

1. How much bait is remaining in the bait station?
    a. Count the number of blocks, or the best estimate of how many partial blocks remain in the station. These should be given as 1 block, 1.5 blocks, 0.75 blocks, etc.
    b. Where small crumbs remain in the bottom of the station, these should be recorded as 0.01 blocks remaining.
2. What evidence of species taking the bait is there?
    a. Are there teeth marks in remaining bait - inspect closely?
    b. Are there droppings coloured by the bait blocks?
    c. Is there any fur inside the station, and can it be discerned as to what species?
    d. Remember to look around the bait station for clues as well.
3. How much bait have you removed?
    a. If any bait has been soiled (chewed, mouldy, broken, wet etc.), it should be removed as waste bait and replaced.
    b. Bait shouldn't be left in a station for more than two consecutive checks, to ensure it is fresh.
4. How much bait have you put back into the station?
    a. Record this as number of whole blocks.
5. Record any additional notes on what you have found.
    a. Useful information can be signs of target species around the bait station such as runs, droppings, food caches (including what has been cached).
6. Resecure the station and ensure the lid is locked and move onto the next one.

APPENDIX 11

Eradication Tools

Option	Pros	Cons	Outcome	Species
First Generation Anticoagulant Rodenticide	Low potency. Delayed onset of symptoms. Less persistent than second generation anticoagulants. Reduced secondary poisoning risk. Reduced risk of non-target poisoning. Low toxicity to raptors. Successfully used on island eradications. Cheaper than second generation anticoagulants. Antidote available	Low potency Multiple feed Large quantity required Repeated applications required Longer access to bait required More labour intensive (as baiting phases of operations must be longer) Non-target species (such as crabs and reptiles) have longer to access bait (i.e. competition with mice) Weather can affect bait because out for longer periods Less persistent (metabolised quickly) Resistance issues	**NOT RECOMMENDED**	
Second Generation Anticoagulant Rodenticide	High potency. Single feed. Delayed onset of symptoms (i.e. prevents neoph obia and bait shyness). Very effective on rodents. Insoluble in water and binds to soil (slowly degraded). Successfully used on island eradications. Efficacy and non-target species data widely available. Range of bait formulations available. Antidote available (long-term treatment required).	Persistence issues (> 9 months) High secondary poisoning risks Non-target impacts recorded. Expensive	**RECOMMENDED**	**RODENTS** **RABBITS**
Avicide (Starlicide)	Moderate to high potency Effective for targeting bird populations Fast acting Degrades in water Binds to soil	Moderate to high potency Requires pre-baiting Hard to manage risks to non-targets Not species specific Can be confrontational to public (birds known to fall from sky)	**NOT RECOMMENDED**	
Traps	No toxin required. Wide choice of trap types available. Quick to service and reset.	Risk of crush injuries Don't always achieve a clean kill Can be bulky and heavy to transport into the field. May require bulky trap boxes to mitigate risks to non-target species.	**RECOMMENDED (as additional tool)**	**RODENTS**
Hunting	No toxin required Effective at removing large vertebrate pests		**RECOMMENDED**	**LIVESTOCK** **RABBITS** **MYNA**
Gene Drive Technology	Environmentally clean Species-specific More humane Safer for non-targets	Socially contentious (deemed "playing god") Not proven to work for island eradications. Hard to control. Prone to	**NOT RECOMMENDED**	
Immuno-	Environmentally clean	Requires ongoing use for sustained control Not proven for island eradications	RECOMMENDED	

APPENDIX 11

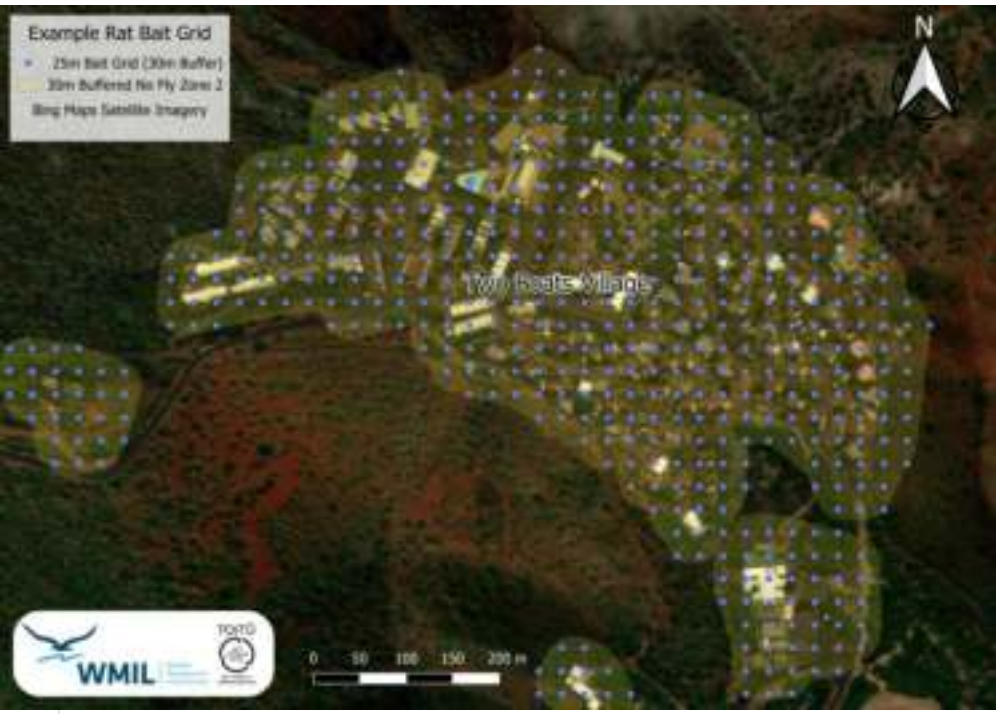
Eradication Tools

Option	Pros	Cons	Outcome	Species
Gene Drive Technology	Environmentally clean Species-specific More humane Safer for non-targets	Socially contentious (deemed "playing god") Not proven to work for island eradications. Hard to control. Prone to	NOT RECOMMENDED	
Immuno-contraceptive	Environmentally clean More humane	Requires ongoing use for sustained control Not proven for island eradications Not all types are species specific and can affect all mammal species.	RECOMMENDED (as additional tool)	RODENTS
Rat Specific Toxin (Norbormide)	Rat specific Greatly reduced non-target risk Proven to remove rat populations on small scales	Not currently proven for island-wide eradication • Palatability issues • Not registered for use in UKOT	NOT RECOMMENDED	
Exclusion fences (Predator-proof fences)	Can provide opportunity to conduct eradications on smaller scale Long-lasting	Require maintenance Can be labour intensive to construct Can be time consuming if materials have to be shipped onto site Require extensive ground work to prepare the site for a fence.	RECOMMENDED	RODENTS RABBITS LIVESTOCK

APPENDIX 12

Example bait station grids

Ship rats – 25 m x 25 m grid



Grids must be ground-truthed.

Bait points moved to optimal locations for each point.

Microhabitat needs to be covered.

Weed plants (Mexican thorn, guava) are key rat habitats/food plants.

Must include inside buildings as well.

House mice – 10 m x 10 m grid