Berwick Bank Wind Farm

Additional Environmental Information (AEI) Submission

AEI02: Addendum to the Derogation Case

Section 5 Handa Feasibility Study

SSE Renewables

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EXECUTIVE SUMMARY

Berwick Bank Wind Farm Limited (The Applicant) is proposing to develop the Berwick Bank Wind Farm in the outer Firth of Forth and Firth of Tay.

The Applicant has, amongst other compensatory measures, proposed to eradicate the brown rat from Handa Island, northwest Scotland, and maintain biosecurity to benefit the breeding success of kittiwake, guillemot, razorbill and puffin on the island.

In relation to the derogation case and accompanying EIA, Marine Directorate Licensing Operations Team (MD-LOT) has requested additional information tabulated below. A response to these questions is summarised in the table and these responses are developed further in the following rat eradication feasibility study report.

Additional information request.	Summary response	Feasibility report reference
RSPB has expectations around a full feasibility study in relation to rat eradication at Handa island, which MD-LOT advises must be provided as additional information.	This report presents the findings of a feasibility study in relation to a rat eradication at Handa Island. It describes the assessment against the seven key feasibility criteria described in the UK Rodent Eradication Best Practice Toolkit (Thomas, Varnham, & Havery, 2017). The reports finds rat eradication on Handa is feasible, subject to further stakeholder engagement and therefore is a suitable compensation measure. Given the close proximity of Handa island to mainland Scotland (350m), the study recommends a buffer 'control and monitored zone' is included to manage the risk of reinvasion. There has been positive engagement with key stakeholders to date. There is no reason at present to consider that a commitment to a robust biosecurity plan would not be forthcoming.	This report.

Additional information request.	Summary response	Feasibility report reference
	A clarification note shall be provided once consultation has been completed.	
NatureScot requests reassurance on measures to minimise loss of great and arctic skua eggs as well as additional information on potential poisoning of non-target species, in particular wintering gulls	The rat eradication project will present no significant additional risk to great and arctic skua eggs or other non-target seabird species, including wintering gulls. Key points: • The eradication of rats from Handa will remove the threat of rats predating on the eggs of all cliff, and ground nesting birds, including great and arctic skua. • The eradication of rats on Handa shall ensure there will not be a requirement for continued long term use of lethal traps and/or rodenticides (apart from biosecurity and incursion response), removing the long term risk of secondary poisoning to non-target species. • A pre-eradication operation field study shall be carried out in the spring period before the return of nesting great and arctic skua. As an additional mitigation against disturbance of prospective nest sites, transect predator trap and monitoring lines shall be routed around the previously recorded nesting sites of great and arctic skua. • The eradication shall be delivered over the winter period before the return of seasonal nesting seabirds, including great and arctic skua, therefore not disturbing nesting seabirds. • The primary toxin recommended to be used for the eradication would be coumatetralyl with bromadiolone used, if required and	This report: Section 3.3, 6.1, 6.4, 10.2, 10.4 and Table 18.

Additional information request.	Summary response	Feasibility report reference
	regulatory approved as a back-up towards the end of the baiting phase. Coumatetralyl, a first generation anti-coagulant rodenticide, is more rapidly metabolised in rats than second generation rodenticides, and in the unlikely event their bodies are then eaten by scavenging overwintering gulls or inquisitive birds of prey, there is very little likelihood that these non-target species will be adversely affected. • Furthermore, the risk of secondary poisoning through eating poisoned rats is low, as most rats die underground or under vegetation in their nests and burrows. • Daily walkovers will be undertaken during the baiting phase and any observed rodent carcasses will be collected for approved off island waste disposal. • The risk of a non-target species directly eating rodenticide is mitigated by the bait station design deterring access to non-target birds (including wintering gulls), and the use of a soft block bait rather than a grain based bait. • Finally, adaptations to the bait stations or bait grid can be made throughout the eradication if interference by gulls is noted.	
NatureScot also asks for clarification on whether the adjacent land on the mainland will be maintained as a rat-free buffer, and whether this extends to other species including hedgehogs, minks and stoats. As noted by	<u>Rat free buffer zone</u> The mainland lies within the 500m 'known' swimming distance for brown rats from Handa Island and its islets, which means rats could potentially swim between these various aspects. Handa Island is therefore considered vulnerable to reinvasion following a rat eradication.	Sections 3.3, 6.6.2, 7.1, 10.2 and 10.4

Additional information request.	Summary response	Feasibility report reference
NatureScot, assessment of effectiveness and feasibility would be required should this measure be taken forward. If this is the case, MD-LOT expects this to be submitted as part of the additional information to be provided on implementation and monitoring.	That said, because there are a wide range of habitats and food sources available to rats on mainland Scotland during the summer and autumnal months, coupled with the consideration that a swim to Handa would require a rat to cross a challenging sea (low temperature, strong tides and currents, high swell and high waves etc), there will be low motivation for rats to leave the mainland in favour of Handa Island. This risk will be minimised further by the inclusion of a rat 'control and monitored' buffer zone on the mainland. It will be important to maintain a robust biosecurity strategy on Handa Island following an eradication operation to ensure any incursions are quickly detected and immediate management action can be taken. Biosecurity measures for vessels and visitors are described. <u>Other predator species.</u> The feasibility study has found hedgehog, mink and stoats have occasionally been observed in very low numbers on Handa Island. There is no recent evidence that shows these other species are still present on Handa Island and therefore no other species are currently being scoped for eradication. A pre-eradication operation field study is described which will include additional assessments of the presence and abundance of these other potential predators on Handa Island and the mainland. The significance of these other species shall be considered, including their incursion risk for target seabirds and a	

Additional information request.	Summary response	Feasibility report reference
	consideration of how their numbers might respond following the removal of rats. Monitoring stations will need to be established and managed over the long term to ensure mainland activity and incursion risk of rats and all other potential mammalian predators can be detected promptly to inform and allow appropriate action to be taken.	

1.0 INTRODUCTION

Berwick Bank Wind Farm Limited (The Applicant) is proposing to develop the Berwick Bank Wind Farm. Berwick Bank comprises of up to 307 wind turbines and will be located in the outer Firth of Forth and Firth of Tay, within the former Round 3 Firth of Forth Zone.

Berwick Bank will include both offshore and onshore infrastructure including the array, offshore export cables to landfall and onshore transmission cables leading to an onshore substation, with subsequent connection to the electricity transmission network. The Scottish Ministers are the primary Regulatory Authority in respect of the necessary consents and licences required for the construction and operation of an Offshore Wind Farm project in Scotland. To allow the Scottish Ministers to properly consider the development proposals, Berwick Bank is required to provide information which demonstrates compliance with the relevant legislation and allows adequate understanding of the material considerations.

The Applicant's Report to Inform Appropriate Assessment (RIAA) concluded that an adverse effect on site integrity could not be ruled out for Black-legged Kittiwake (hereafter Kittiwake) *Rissa tridactyla*, Common Guillemot (hereafter Guillemot) *Uria aalge*, Razorbill *Alca torda*, and Atlantic Puffin (hereafter Puffin) *Fratercula arctica*. These are collectively referred to as the 'key species'.

Two colony-based measures are proposed as compensatory measures for the proposed development and several others have been explored as part of a thorough compensatory measure identification and selection process. It is proposed that the final measures to take forward are:

i. Rat eradication and biosecurity to benefit kittiwake, guillemot, razorbill and puffin nesting at Handa Island;

ii. Safeguarding the Dunbar Kittiwake colony through wardening and targeted work to reduce human disturbance and other colony-related pressures.

This document concerns the proposed compensation measures to eradicate the brown rat from Handa, an island off the northwest coast of Scotland (Figure 1).

Figure 1. Location map and aerial images: Handa Island (courtesy of Google Earth and Ordnance Survey)

In relation to the derogation case and accompanying EIA, Marine Directorate Licensing Operations Team (MD-LOT) have formally requested the following additional information:

- RSPB has expectations around a full feasibility study in relation to rat eradication at Handa island, which MD-LOT advises must be provided as additional information (this report).
- NatureScot requests reassurance on measures to minimise loss of great and arctic skua eggs as well as additional information on potential poisoning of non-target species, in particular wintering gulls (this report Section 3.3, 6.1, 6.4, 10.2, 10.4 and Table 18).
- NatureScot also asks for clarification on whether the adjacent land on the mainland will be maintained as a rat-free buffer, and whether this extends to other species including hedgehogs, minks and stoats. As noted by NatureScot, assessment of effectiveness and feasibility would be

required should this measure be taken forward. If this is the case, MD-LOT expects this to be submitted as part of the additional information to be provided on implementation and monitoring (this report Sections 3.3, 6.6.2, 7.1, 10.2 and 10.4).

The scope of work for the feasibility study on Handa Island comprises the following 4 tasks:

Task 1: Site reconnaissance visit in June 2023 to observe seabird nesting activity, to describe the environmental setting and assess the safety and practicalities of establishing a baiting grid, plus consider local stakeholder interests and biosecurity requirements. A photographic record was taken to support the observations.

Task 2: Desk study to collate and assess currently available information on predator activity across Handa Island and consider the islands vulnerability to reinvasion following a predator eradication [1].

Task 3: Assessment against the following seven key feasibility criteria described in the UK Rodent Eradication Best Practice Toolkit (Thomas, Varnham, & Havery, 2017):

- Technically feasible
- Sustainable
- Socially acceptable
- Politically and legally acceptable
- Environmentally acceptable
- Have Capacity, and be
- Affordable.

Task 4: Feasibility Study Report (this document) shall document the results of the site visit and desk study and will report the findings against the seven feasibility criteria. Based on these answers the key feasibility criteria have been considered and recommendations made on whether eradication is feasible or not. Where additional data is required to support the method of eradication these have been described.

[1] Primary data source: EOR0766_Berwick Bank Wind Farm Application - 4. Derogation Case - Colony Compensatory Measures Evidence Report

2.0 ENVIRONMENTAL SETTING

2.1 SITE DETAILS AND DESIGNATIONS

Handa Island is 367 hectares in area and the closest point is located approximately 350m from mainland Scotland. A photograph log compiled during a preliminary island reconnaissance visit in June 2023 is available on request. This provides images of the island's location, boat access arrangements, local habitat, geographical setting and seabird activity.

Handa has high Torridonian sandstone sea-cliffs that provide tiered ledges used by a range of nesting seabird species. It is designated as an SPA and at the time of designation in 1990 supported populations of European importance for Guillemot (98,686 individuals – 9.3% of the British population and 2.9% of the North Atlantic biogeographic population) and Razorbill (16,394 individuals – 11% of the British population and 1.9% of the Alca torda islandica population). It also supported nationally important colonies of Kittiwake (10,732 pairs, 2.2% of the British population), as well as several hundred Puffins (735 AOB). The most recent counts show there are an estimated 68,524 Guillemots (individuals), 3,749 Kittiwakes (AON), 5,047 Razorbills (individuals) and 208 Puffins (individuals). These are the key species that the compensatory measure would benefit.

As well as the key species, Handa also supports nationally important numbers of Great Skua *Stercorarius skua*, which numbered 66 pairs (0.8% of the GB population) at the time of designation in 1990. Since then, numbers increased to 283 pairs in 2018, with numbers in 2022 reduced to just 73 AOT. Northern Fulmar *Fulmarus glacialis* numbered 3,500 pairs (0.7% of the GB population) at the time of designation in 1990 but has reduced to 1,879 pairs. It also supports breeding Arctic Skua (20 AOT, SWT 2021). Other breeding species include European Shag *Phalacrocorax aristotelis*, Common Eider *Somateria mollissima*, Red-throated Diver *Gavia stellata*, Common Gull *Larus canus*, Herring Gull *Larus argentatus*, Great Black-backed Gull *Larus marinus*, Arctic Tern *Sterna paradisaea*, Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula* and Snipe *Gallinego gallinago* (SWT 2021). Handa also supports a range of maritime grassland and heath vegetation. Tree cover is no longer present.

Seabird species that have formerly bred on Handa but were thought lost include Common Tern *Sterna hirundo* (last bred successfully in 2002) and Arctic Tern *Sterna paradisaea* (last bred successfully in 2015). However, tern chicks and fledglings (most likely Arctic) have been seen in July 2022 for the first time in 7 years. Historically Black Guillemot *Cepphus grille* once bred on Handa and Harvey-Brown & Buckley (1887) reported that 'the rats had managed to dislodge them'. Also White-tailed Sea Eagles *Haliaeetus albicilla* once bred on Handa but have not bred since the 1800s (Harvey-Brown & Buckley 1887), although a non-breeding pair was sighted throughout the 2021 season for the first time in many years (R. Potter, SWT, *pers. comm*).

2.2 SITE MANAGEMENT

Handa Island is managed by the Scottish Wildlife Trust (SWT) and is part of the Scourie Estate. The island management organisation comprises one ranger and up to six residential volunteers during the summer months.

The ranger and volunteer team carry out bird counts and productivity monitoring, with Guillemot, Kittiwake, and Fulmar monitoring plots counted regularly throughout the breeding period, each year. All island counts of Guillemot, Kittiwake, and Fulmar are conducted every 5 years, whilst all island counts for terns and gulls are every 6 years. All island counts of Shag, Arctic Skua and Great Skua are carried out every 1-2 years. Other routinely recorded information includes dates of first eggs and chicks, breeding and migrant casual bird sightings, records of other notable flora and fauna sighted during the season, as well as monitoring rat activity through observations of the rat chew stations for signs of activity (Section 3.0).

The ranger and volunteer team also hold responsibility for ensuring that the paths around the island and the bothy itself, are maintained. They deal with regular visitor trips to the island, undertaking welcome talks and detailing conservation issues, such as ground nesting birds, fragile habitats and relevant health and safety issues. They are also responsible for producing interpretive material and for fundraising and selling souvenirs, in addition to carrying out school visits and guided walks.

Over the 2021 season Handa Island was open from the last week of March until the first week of September, with ferry crossings taking place regularly except during periods of poor weather. The island welcomed 6,661 visitors over the course of the breeding season (SWT 2021). Pre COVID-19 pandemic visitor numbers were just below 9,000 for the years 2017 – 2019 (R. Potter, SWT *pers. comm*.).

2.3 HANDA ISLAND RECONNAISSANCE VISIT

A field reconnaissance visit was conducted by Ian Cain on June 14th 2023. This visit comprised walkover and photographic survey of accessible areas of Handa island and the adjacent mainland.

Key observations:

- Handa island is a short ferry ride from Tarbet 5km north of Scourie (Figure 2), accessed by a minor public road.

Figure 2. Satellite image of Tarbet and surrounding land use (courtesy of Google Earth)

- The landscape around Tarbet is rugged and sparsely populated. It is dominated by undulating moorland, rocky outcrops, cliffs and lochans. Tree cover is sparse.
- Human activity around Tarbet is associated with several houses, a café, public toilets and car park, ferry operations and material storage waste collection facilities (Figure 3, 4 and 5).
- Industrial activity in the region is limited to Loch Duart Ltd which operates active aquaculture (salmon farming) in Laxford Loch, located some 2 km north east of Tarbet (Figure 1).[2]
- Handa Island is accessible to visitors, SWT staff and others by boat from the jetty at Tarbet. A regular ferry (a Rigid Inflatable Boat) runs Monday through Saturday between April and August subject to suitable weather conditions[3].
- Images showing Handa Islands visitor facilities, paths, heath and grasslands, coastline and high cliffs are shown in Figures 6 through 9.

[2] Welcome to Loch Duart - Unrivalled Scottish Salmon

[3] https://handa-ferry.com/

Figure 3. Photograph showing access road into Tarbet and local residence.

Figure 4. Photograph showing Tarbet jetty, residence/ cafe and ferry operating shed with material storage.

Figure 5. Photograph showing Jetty and RIB leaving for Handa Island.

Figure 6. Photograph showing RIB arriving on Handa Island.

Figure 7. Photograph showing SWT Visitor Information building.

Figure 8. Photograph showing visitor path through heathland showing mainland hills and cliffs in the distance.

Figure 9. Photograph showing Handa Island north and the open heath and grassland, visitor path and high cliffs.

3.0 PREDATOR SPECIES, ABUNDANCE, BEHAVIOUR AND UNCERTAINTIES

3.1 INVASIVE NON-NATIVE SPECIES: RATS

The presence of invasive non-native Brown Rat *Rattus norvegicus* is discussed and reported in the Derogation Case – Compensatory Measures evidence Report[4]. Key points:

- The last permanent human inhabitants of Handa left in 1848, and it is considered likely that brown rats were introduced during the period between 1848-1867 when the island was farmed for sheep. Rats were blamed for reducing numbers of Black Guillemots and for driving Atlantic Puffins 'off the tops at Handa into more secure crevices in the face and slopes.
- In 1962 Handa Island became a nature reserve, and annual wardens' reports show that a population of rats persisted, particularly around the coast and at the bothy, the only inhabitable building on the island.
- Although most cliff-nesting bird species were either stable or increasing in the mid-90s, it was felt that rats were inhibiting the expansion of puffin, and the recolonisation of black guillemots. It was also felt that other ground or burrow nesting seabirds such as European Storm Petrel and Manx Shearwater might be able to colonise potentially suitable habitat were rats to be removed.
- Work was first carried out by SWT in March 1997 to remove rats from Handa using bait poisoned with warfarin.
- Following eradication efforts, a monitoring programme was devised so that SWT staff could routinely check for further incursions and/or evidence of the eradication work not being fully successful. Unfortunately rats were monitored and observed to be still active. It was not fully ascertained if the eradication project had failed or if a new incursion had taken place from the mainland.
- Rat activity was again observed in 2007 through to the present day.

3.2 OTHER INVASIVE SPECIES

Invasive rats are known to be active on Handa Island and possibly also other invasive species. The presence of other invasive species is also discussed and reported in the Derogation Case – Compensatory Measures evidence Report. Key points:

- Handa Island supports a population of European rabbit. Historically numbers have varied, rabbits were absent in the late 1990s, but they are now extensive and not controlled. Rabbits

[4] EOR0766_Berwick Bank Wind Farm Application - 4. Derogation Case - Colony Compensatory Measures Evidence Report

are not predatory on seabirds, but their impacts including possible displacement of burrow nesting seabirds, has not been assessed by SWT or others.

- In 2002 the presence of a 'mystery mammal' was identified through the appearance of scat. The scat was sent off for identification, and although expert consensus differed, it was generally agreed to be from European hedgehog *Erinaceus europeaus*. Hedgehogs, although unlikely to access sheer cliff faces, can predate the eggs of ground nesting birds such as Puffins, terns and skuas. The hedgehogs were observed again in 2003, 2004, 2005 and 2007, although there were no signs of hedgehog in 2008, 2009, 2010 or 2011. In 2012 Hedgehog scat was found again, although hedgehog has not been sighted since.
- Other invasive mammals that have occurred on Handa include a stoat *Mustela erminea* in 2008 and in 2020, and an American mink *Neovision vision* in 2021. The latter was caught using a mink trap and humanely despatched.
- There is also considered to be a risk of incursion by House Mouse *Mus musculus*, though this has never occurred.

3.3 Uncertainties and Pre eradication operational studies

Existing information indicates brown rats (*Rattus norvegicus*) are present and likely to be the most significant invasive mammalian predators on and around Handa Island. Pre-eradication operational field studies are recommended to address uncertainties and better inform the understanding of the abundance and distribution of the rats and confirm the presence or absence of other potential predator species. During these studies physical monitoring and trapping shall be supported by observational assessment, interviews and further desk study. The potential for mesopredator release shall also be considered, so species such as shrews, wood mice, house mice, hedgehog, mink, stoats and rabbits will be part of the assessment.

The pre-eradication operational field studies should ideally be delivered outwith the seabird breeding season and carefully managed to ensure monitoring operations do not disturb resident, or over wintering birds. The methodology shall adopt best practice and run multiple types of abundance estimates using index trapping, tracking tunnels, wax blocks, and trail cameras to assess rodent and potentially other invasive predator density and distribution across the study area.

Key uncertainties and questions to be answered during the recommended pre eradication operational field studies are:

i. Which species of rat(s) are present across the study areas? If, as appears likely, brown rats are the only rat species present, then a more widely spaced grid of bait stations could be used than if black rats were present as well as brown rats. This will have impacts on the resources required. The two species also have different ecological impacts on native species, which should be taken account when delivering the proposed eradication.

ii. What is the distribution, population characteristics and diet of the rats on Handa Island and the adjacent mainland? All rats caught in the kill-traps shall be necropsied (e.g. Figure 10). Rat species (black vs brown) shall be identified, and the following measurements shall be taken Head - body length (HBL), tail length, nose to ear, right ear, and right hind foot with claw. In addition, weight, colour, age (juvenile or adult), sex, body condition, stomach contents (to provide information on diet and infer information on whether the rodents have been predating on seabird eggs, nestlings, or adults) and breeding status shall be recorded.

Figure 10. Photographs showing trapped rat being prepared for necroscopy and assessment of stomach contents for evidence of diet

iii. Tissue samples shall be taken from rats that have been trapped for DNA analysis. This is required to answer the questions:

- Are rats on Handa genetically different to rats on the mainland? A genetic comparison shall be made between the rats on Handa Island, its islets and stacks and with those of a possible source population on the mainland. This shall involve taking representative DNA samples from each population and testing for genetic comparison using the analytical services of the Department of Applied Science at Huddersfield University. The DNA testing completed during the pre-eradication operational study will also provide information on the Handa island specific rat populations as a basis for genetic comparison if rodents are discovered and collected on the island after an eradication programme has been completed. This will gauge whether there was a reinvasion, or the eradication had failed. These data are not available from the previous eradication conducted on Handa and therefore it is not possible to determine if the more recent rat activity is the result of a new invasion and/or a failed original eradication.
- Do the rats show resistance to rodenticides? Resistance to a number of rodenticides is known in the UK, particularly for Brown rat (*Rattus norvegicus)*. Tests for resistance shall be carried out on the DNA samples. This will be vitally important to deciding which rodenticide formulations will be most effective, whilst also minimising any potential adverse impact to non-target species in any subsequent eradication project (See also Section 7).

iv. Is there evidence of the rats eating a marine diet? Tissue samples shall be submitted to the School of Biological Sciences, University of Aberdeen for stable isotope analysis to assist the study to infer information on the composition of the rodent's diet includes a marine/ seabird element.

v. Are other predators (including mink, stoats and hedgehogs) still present on Handa and should they be included in any proposed eradication project? The feasibility study has found hedgehog, mink and stoats have occasionally been observed in very low numbers on Handa Island (Section 3.2). There is no evidence obtained so far that suggests these other species are still present and predating on seabirds and therefore no other species are currently being scoped for eradication. A pre-eradication operation field study (Section 6.0) is described which will make additional assessment of the presence and abundance of potential predators other than rats and the significance of these other species shall be reported, including possible future population expansion and /or incursion risk to target seabirds. The techniques to be used in these field studies shall comprise non-lethal monitoring techniques, namely ink tunnels, live capture traps and a network of trail camera traps on Handa Island and on the adjacent mainland to gather additional data on the abundance of other potential predators for possible consideration in the eradication scope of work. Additional consideration shall also be given during the pre-eradication operation field studies to a possible response by these other potential predators to the removal of the previously 'competitive' rats.

3.4 BROWN RATS: REGIONAL AND GLOBAL ABUNDANCE

Although originally from China and Mongolia, brown rats are now found throughout the world (Nowak, 1999; ISSG, 2010; Seebens *et al*., 2017; King & Forsyth, 2021). Brown rats have been identified as one of the world's 100 worst invasive species (Lowe *et al.,* 2000, ISSG 2010).

Brown rats were inadvertently introduced into the United Kingdom (UK) around 1720 with ship movements from Europe (Nowak, 1999). The last permanent human inhabitants of Handa left in 1848, and it is considered likely that Brown Rat *Rattus norvegicus* was introduced during the period between 1848-1867 when the island was farmed for sheep (Stoneman & Zonfrillo 2005).

3.5 BROWN RATS: CHARACTERISTICS AND BEHAVIOURS

Brown rats are large, with a stout body, heavy tail, small ears, and pale feet (Novak, 1999; King & Forsyth, 2021). Brown rats can grow up to 275 mm in length and weigh up to 400 g (Cunningham & Moor, 1996; King & Forsyth, 2021). They usually have a grey belly with a brown back coat, with long black guard hairs (Cunningham & Moor, 1993; King & Forsyth, 2021).

Males tend to be larger than females, and when mature, have a prominent scrotum at the base of the tail. Usually only breeding females have visible nipples (Novak, 1999; King & Forsyth, 2021). Brown rats have acute senses of smell, touch, taste, and hearing (King & Forsyth, 2021). Brown rats are omnivorous (but can also be specialist) feeders, taking advantage of any potential food source and will often cache food (Nowak, 1999; King & Forsyth, 2021).

Brown rats are voracious consumers of vegetation (seeds, nuts, seaweed and fruit), as well as other animals, insects and birds when available. Natural sources of food tend to be a high proportion of their diet, but human derived products (stores, vegetables, food waste and crops) are also targeted (King & Forsyth, 2021).

Brown rats are agile climbers, but usually climb less that black rats (*Rattus rattus)* (Nowak, 1999; King & Forsyth, 2021). Often associated with water, brown rats are strong swimmers and as discussed in Section 8.0 have been recorded swimming between islands up to 1 km apart and possess a theoretical maximum swimming distance of 2km (Russell *et al*., 2005; Russell *et al*., 2008; King & Forsyth, 2021).

Brown rats are extensive burrowers and create elaborate tunnels and tracks (Nowak, 1999; King & Forsyth, 2021). Food is commonly cached in these burrow systems and droppings are usually deposited in groups (or latrine sites) along the tracks, at feeding sites and on prominent rocks. Tracks and runs are common in areas of brown rat activity (King & Forsyth, 2021). Small groups of brown rats will live together in colonies and other rats will be aggressively removed from the territory (King & Forsyth, 2021). One dominant male will breed with the resident females with younger and juvenile males being evicted at certain ages and/or when the colony reaches higher numbers (Calhoun, 1963; King & Forsyth, 2021).

Brown rats are associated with a range of habitats from barren ground, coasts, islands and grassland to lush forest as well as human dwellings, buildings, and farms (Nowak, 1999; King & Forsyth, 2021). Home range for brown rats can vary from 0.1 ha (usually in urban areas) to 3 ha in all types of habitats; this depends on food availability and habitat quality (Moors, 1985; Nowak, 1999; King & Forsyth, 2021). Males have larger home ranges than females (as they prefer to stay close to breeding sites); this may vary depending on habitat quality, food availability, predation pressure and other factors (Nowak, 1999; King & Forsyth, 2021).

Brown rats construct nests out of various items including vegetation (grass, twigs and leaves), newspaper, cardboard, and feathers, with new material added regularly (Nowak, 1999; King & Forsyth, 2021). They can breed throughout the year, but this generally depends on food availability and habitat (Nowak, 1999; King & Forsyth, 2021). Gestation is up to 24 days and litter size vary from 3 to 10 young (usually 6-8); the average annual production can be up to 40 young per year (Nowak, 1999; King & Forsyth, 2021). The young are weaned when they are about 28 days old (about 40 g) and can be sexually mature at two to three months old (Nowak, 1999; King & Forsyth, 2021). Most brown rats usually live between 12 and 18 months in the wild, with females generally living longer than males (Davies, 1953; King & Forsyth, 2021).

Brown rats are nocturnal and generally shy; however, this depends on habitat, predation pressure, hierarchy, disturbance, and food availability (Calhoun, 1963; King & Forsyth, 2021). Although brown rats actively explore their surroundings, they are known to be very wary of new or strange objects in their home range, i.e., neophobic (King & Forsyth, 2021). This behaviour can affect control and removal programmes in cities, farms and on islands.

Brown rats are commonly infested with fleas and mites as well as being known carriers of several diseases, including *leptospirosis, trichinosis*, *toxoplasmosis* and *salmonellosis* (King & Forsyth, 2021).

4.0 PREDATOR IMPACT AND OPPORTUNITIES FOR SEABIRD RECOVERY

4.1 BROWN RAT IMPACT ON SEABIRDS

Rats are one of the most widespread invasive species, occurring on 80% of the world's islands (Atkinson, 1985; Jones *et al*., 2008; Spatz *et al*., 2014; Dawson *et al*., 2015). Rats have had devastating impacts on islands through predation, competition, and habitat modification (Imber, 1985; Towns *et al*., 2006; Jones *et al*., 2008; Harris, 2009; Mulder *et al*., 2009; Hilton & Cuthbert, 2010; Croxall *et al*., 2012; King & Forsyth, 2021), but have been successfully removed from islands ranging in size from 1 to 36,000 hectares (Towns & Broome, 2003; Howald *et al*., 2007; Bell, 2019; Martin & Richardson, 2019).

Brown rats have been recognised to have direct predatory impacts on seabirds, their eggs and their chicks, especially the burrow-nesting species (Moors & Atkinson, 1984; Towns *et al*., 2006; Jones *et al*., 2008; Hilton & Cuthbert, 2010; Bell *et al.*, 2011; Booker & Price, 2014; Booker *et al*., 2018; King & Forsyth, 2021).

Brown rats have also been implicated in the decline of other small mammals (Harris, 2009; Shepherd & Ditgen, 2012). Seeds and fruit are particularly vulnerable to brown rat predation and consumption (Allen *et al*., 1994; Grant-Hoffman *et al*., 2010; Pender *et al*., 2013).

Brown rats will be having an adverse direct impact on the Handa island ecosystem including:

- predation of seabirds, chicks and eggs;
- predation of invertebrates and small mammals; and
- reduced regeneration of plants.

4.2 OPPORTUNITY FOR SEABIRD RECOVERY FOLLOWING RAT ERADICATION

4.2.1 Global experience

The successful eradication of black and brown rats from Lundy Island, England (500 ha; Appleton *et al*., 2006; Lock, 2006; Bell, 2019), brown rats from Ailsa Craig, Scotland (100 ha; Zonfrillo, 2001; Zonfrillo, 2002), Ramsey Island, Wales (256 ha; Bell *et al*., 2019, Isle of Canna & Sanday (1314 ha; Bell *et al*., 2011), St Agnes & Gugh, Isles of Scilly (142 ha; Bell *et al*., 2019) and the black rats from the Shiant Isles (143 ha; Main *et al*., 2019) demonstrates how these techniques can be utilised on islands around the UK.

Following the successful eradication of rats from islands and provision of rat free nesting sites, native species, particularly seabirds, have increased in density and range and often diversity (Bellingham *et al*., 2010; Buxton *et al*., 2016; Newton *et al*., 2016; Booker *et al*., 2018; Brooke *et al*., 2018; King & Forsyth, 2021). Native plant biomass on islands has also increased often within 10 years of removing rats (Towns *et al*., 2006).

Both cliff nesting and burrowing seabird species have shown significant increases following the eradication of brown rats from islands within the UK and around the globe (Bellingham *et al*., 2010; Le Corre *et al*., 2015; Capizzi *et al*., 2016; Booker *et al*., 2018; RSPB, 2018). On Lundy Island, guillemot, razorbill, kittiwake (*Rissa tridactyla*), and puffin, have all increased in number and distribution across the island since 1981 with the most significant increases following the 2002 rat eradication (Booker *et al*., 2018). Similar trends for Manx shearwater (*Puffinus puffinus*) and European storm petrels (*Hydrobates pelagicus*) have been recorded on Lundy Island (Booker & Price, 2014; Booker *et al*., 2018) and after the brown rat eradication on Ramsey Island (Bell *et al*., 2019). The breeding success and productivity of puffin and razorbill increased on the Shiant Isles following the black rat eradication (RSPB, 2018). Storm petrels were also confirmed to be breeding on the Shiants and bred successfully in 2018 for the first time on record (RSPB, 2018).

4.2.2 Opportunity for seabird expansion on Handa Island

During the island reconnaissance visit observations were made and a photographic record was taken of the cliffs, islets and stacks that are accessible for observation by island visitors.

Key observations:

- Seabirds on Handa island comprise breeding populations of guillemots, razorbill, kittiwake, fulmar and moderate to low numbers of puffin and skua (great and arctic).
- The northern cliffs, stacks and islets had ledges and crevices that were home to the largest numbers of nesting guillemot, razorbill, kittiwake and fulmar. It was noticeable that these seabirds preferred the lower and middle ledges of the cliffs on the main island, but on offshore stacks and islets the populations were more evenly distributed, including on the higher elevations.
- The tops of the cliffs on the main island were typically gently sloping and grass covered. These elevations had low numbers of seabirds. The habitat is particularly suited to burrow nesting puffins, but numbers appeared low.
- The main Islands grassland and heathland is accessible to nesting skua and other ground nesting birds. However populations of all ground nesting birds appeared to be sparse on the day of the field reconnaissance visit.
- It was evident that the open grassland and gently sloping higher elevations of the main island cliffs are all easily accessible for inquisitive and predatory rats. It is considered highly likely that rats are active across these areas, and this activity will be inhibiting seabirds and other ground nesting species from nesting more successfully across these zones.
- The close proximity of the main Island of Handa within its network of neighbouring islets and rock stacks means determined rats could potentially swim between these features; this means Handa, and all of its islets and stacks would have to be considered part of an eradication operation together with a buffer control and monitored zone on the mainland.
- A series of images are shown in figures 11 to 16 illustrate these observations.

Figure 11. Aerial and Ordnance Survey image showing the locations of Handa Island's north west cliffs, islets and stacks observed during the site visit.

Figure 12. Photograph showing seabirds nesting on islet (Blue Box Figure 11) through all levels of cliff face including high ledges.

Figure 13. Photograph showing high seabird nesting density on middle and lower ledges on Handa main island cliffs Note: i. Low density of nesting seabirds on grassy slopes and high ledges (e.g. yellow bounded areas), and ii. Higher elevations easily accessible for rats (red arrows).

Figure 14. Photograph showing high seabird nesting density on sea stack (green box Figure 11) across all suitable ledge and elevations.

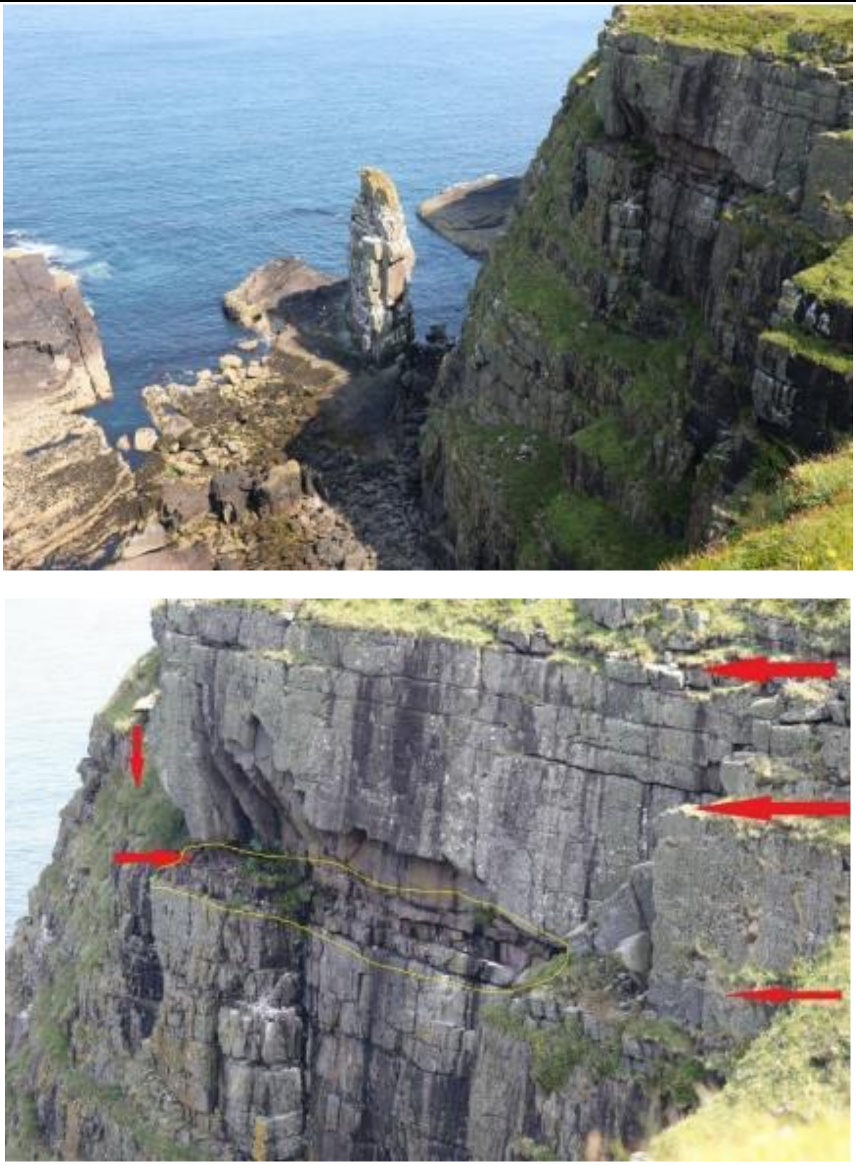

Figure 15. Photographs showing low seabird nesting density (e.g. yellow bounded area) on Handa main island cliffs opposing the sea stack shown in Figure 14. Note all elevations accessible to rats (e.g. red arrows).

Figure 16. Photograph showing further example of low seabird nesting density (e.g. yellow bounded area) on high elevations of Handa main island cliffs opposing the sea stack shown in Figure 14. Note high elevations easily accessible to rats (e.g. red arrows).

5.0 PREDATOR ERADICATION FEASIBILITY STUDY: GOALS, OBJECTIVES AND OUTCOMES

This scope of work considers if it is feasible to remove invasive predators from Handa and provide improved conditions for seabirds to breed more successfully and for colonies to grow.

The current best UK best practice on ground-based rodent eradication states that to properly assess the feasibility of removing rats the project must meet the criteria described in the following seven sections that (Thomas, Varnham & Havery 2017:

- there is an acceptable and effective technical approach;
- the project is sustainable (in that reinvasion risks can be managed);
- the project is socially acceptable;
- the project is politically and legally acceptable;
- the project is environmentally acceptable;
- there is sufficient capacity to carry out the project successfully; and
- it is financially viable.

Sections 6 to 12 consider each of these criteria in turn.

6.0 Technical Feasibility

6.1 Options Analysis

The following options have been reviewed in line with the principles established by the UK Rodent Eradication Best Practice Toolkit:

- Option 1: Do nothing.
- Option 2: Enhanced rat control.
- Option 3: Brown rat eradication.

6.1.1 Option 1: Do nothing

The "do nothing" option is essentially maintaining the status quo for the management of Handa Island (Table 1). This option would not require the resources for the proposed rat eradication and appropriate biosecurity measures. However, this approach would result in no reduction in predation or mammalian predators on the Handa islands group, continued depredation of breeding seabirds and land birds likely leading to the loss or continued absence of species.

Table 1. Advantages and disadvantages of Option 1: Do nothing.

Advantages	Disadvantages
The effort to deliver the rat eradication project will not be required. The SWT, ferry operator, public and landowners can continue with current minimal biosecurity measures and there will be no changes for them. The risks of unintended ecological changes will not happen.	The expected environmental benefits from a successful eradication will not be realised. Risk of disease transmission to humans and other wildlife remains. The ongoing costs of control continue. Rat population remain (and subsequent impacts on seabirds and other species by rats continue).

6.1.2 Option 2: Enhanced rat control

SWT undertake limited rat control on an ongoing basis as part of their rodent control around buildings. This activity does not maximise the opportunities to deter rats from predating on seabirds. To increase the level of effective rat control to protect the breeding success of seabirds across Handa Island would require operators to be resourced and to have a comprehensive understanding as to where their controls would be best placed to achieve suitable outcomes (

Table *2*).

Table 2. Advantages and disadvantages of Option 2: Enhanced rat control.

Advantages	Disadvantages
The effort to deliver the rat eradication project will not be required. The SWT, ferry operator, public and landowners can continue with current minimal biosecurity measures and there will be no changes for them. The risks of unintended ecological changes will not happen. Limited level of environmental benefits in areas where rat control is undertaken.	The environmental benefits of targeted controls will not be as great as a successful full-island group eradication. Long term use of rodenticide and traps extends risk of secondary poisoning to non-target species, including gulls and raptors. Rat population remain (and subsequent impacts on seabirds and other species by rats continue). On longer term scale, resource requirements are high and required on a yearly basis. Compared to an eradication, it possible that more animals will be killed in the long term due to a combination of rats killed by rodenticide and traps and seabirds predated by rats.

6.1.3 Option 3: Rat eradication

This is the recommended option. Brown rats are known predators of ground and cliff and burrow nesting birds and can drive significant and negative impacts on ecological processes (Table 3).

Table 3. Advantages and disadvantages of Option 3: Rat eradication.

Advantages	Disadvantages
The expected environmental benefits (i.e. seabird, invertebrate, and vegetation recovery and expansion) from a successful eradication will be realised. These vectors for disease transmission to humans will no longer be present. Ongoing control costs to SWT for rats will cease. Long term use of rodenticides would not be needed on Handa (apart from biosecurity and incursion response), removing the risk of secondary poisoning to non- target species.	The local ferry operator, landowners and members of the public must be engaged in adopting new biosecurity measures. Unintended ecological changes could happen if not diligently managed.

6.2 Eradication Analysis

Any eradication operation is not taken lightly, and this assessment does ensure:

- That non-lethal measures have been assessed and found not practicable.
- That killing is an effective way of addressing the problem.
- That killing will not have an adverse impact on the conservation status of other non-target species.

Table 4 summarises the advantages and disadvantages and practicality for each rat control or eradication option.

Table 4. Details and practicality of options for eradicating brown rats from Handa island.

Option	Advantages	Disadvantages	Outcome
Prevention (i.e. rat-proofing).	Environmentally clean. Proofing areas. prevents damage and effects of rats. Useful for buildings and small areas only.	Does not deal with rats already present (which can still cause damage or have impacts). Rat-proof fencing expensive. Non-lethal; can move problem to another location. Usually combined with other methods. Best suited for small areas. Not suitable for islands within swimming range of rats. Little value alone.	Impractical
Rodent dogs.	Targeted control. Environmentally clean. Use for detection of surviving rats.	Labour intensive. Expensive. Rats have to be humanely killed. Untested for island-wide eradication projects. Ethical concerns.	Impractical

Option	Advantages	Disadvantages	Outcome
Repellents	Sound or chemical options. Targeted control. No welfare impacts.	Little to no success (Mason & Litten 2003). Rats habituate to repellent. Non-lethal, can move problem to another area. Little to no use on an island-wide situation.	Impractical
Aluminium phosphide (Fumigation).	Targeted control (burrows only). Lethal: full eradication.	Needs knowledge of habitat and location of rat burrows. Risks to general public Risks to other non-target species. Professional use only. Outdoor use only. Ethical concerns. Untested for island-wide eradication projects.	Impractical
Immuno-contraception.	Could be long-term solution. Humane.	At research stage only. Concerns regarding loss of control. Non-target species concerns. Irreversible. Public concern.	Impractical and experimental.
Biological control	Long-term solution.	Involves releasing another possible problem animal. Non-target impact concern. Ethical concerns. Legal issues.	Impractical.

Option	Advantages	Disadvantages	Outcome
Kill traps (i.e., snap, spring, A24 or break-back traps).	Lethal (rapid death). Targeted control, good for local small area controls and monitoring projects. None polluting. Can be used by general public. Range of traps commercially available.	Untested and impracticable for island-wide eradication projects. Labour-intensive. Equipment intensive – expensive. Resource consuming; need to be checked twice daily (if set permanently). Welfare issues/ethical concerns if not checked twice per day. Sea and weather conditions will not allow all locations to be checked twice per day. Only legal traps can be used (under relevant Pest Control and Trapping Acts). Experienced trappers needed. Requires good accessibility. Risk to non-target species.	Impractical and experimental.

Option	Advantages	Disadvantages	Outcome
Live trapping.	Non-polluting. Non-target species can be released unharmed. Targeted control. Range of traps commercially available.	Labour-intensive. Expensive. Experienced trappers needed. Requires good accessibility. Welfare issues (i.e. while animal in trap and kill method) if not checked twice per day. Need to be checked twice daily. Only legal traps can be used (under relevant legislation). Rats have to be humanely killed. Untested for island-wide eradication projects. Ethical concerns.	Impractical
Electrocution traps.	Targeted control. Lethal (rapid death). Non-toxic.	Needs sufficient current (i.e., power source). Labour-intensive and expensive. Welfare issues and ethical concerns (public perception of traps). Only legal traps can be used (under relevant legislation). Non-target issues. Untested for island-wide eradication projects.	Impractical and experimental.

Option	Advantages	Disadvantages	Outcome
		No detailed clinical data on efficacy. humaneness, welfare, or other effects.	
Anticoagulant rodenticides.	Efficient. Large areas covered quickly. Most widely used approach to control rats. Most cost-effective method of controlling substantial infestations. Tested and successful method for one-off island-wide eradication projects. Follows internationally recognised best practice standards (see below). Range of application methods. Can be used in bait stations to reduce risk to non-target species. Antidote available Range of rodenticides available (e.g. first generation or second generation). Range of formulation available (e.g. grain, wax block, pellets etc.). Available for use by the public and professionals.	Use of toxin. Persistence in environment (toxin dependent). Non-target impacts (toxin dependent). Ethical concerns (minimised compared to other options). Resistance issues with prolonged use. Legal requirements for certain rodenticide use (i.e. brodifacoum restricted to indoor use only, bait station use required for some rodenticides, etc.). Implies coverage of whole area. Requires use of adequate baits and bait stations. Disposal requirements. Health and Safety hazards including working at height, and exposure to toxic substances.	Practical and effective. Tested and effective. Suitable and sufficient health and safety risk assessment and safe operating procedures.

The only practical, ethical and effective option to reduce rodent impacts on seabirds and the wider ecosystem is the eradication of brown rats using anticoagulant rodenticides.

The use of self-resetting traps (such as A24) as the key eradication option has been discounted due to the size of the island as well as the untested nature of these traps in this environment. It is recommended that A24 traps could be assessed for use on remote stacks, islets and difficult to access cliffs and also for long-term biosecurity potential during the eradication operational planning phase of work.

6.3 Toxin Analysis

The use of anticoagulant rodenticides is currently the most widely recognised effective method of eradicating rodents from islands. Table 5 provides the advantages and disadvantages and practicality of available anticoagulant rodenticides in the UK. Second-generation anticoagulant rodenticides such as brodifacoum or flocoumafen are illegal for use outdoors in the UK and have not been included.

Table 5. Assessment of available anticoagulant rodenticides (outdoor use only) for eradicating brown rats from the Handa islands group.

Toxin	Advantages	Disadvantages	Outcome
First-generation			
Warfarin	Low toxicity (reduces risk to non-target species). Delayed onset of symptoms (i.e., prevents neophobia and bait shyness). Less persistent than second generation anticoagulants Reduced risk of non-target poisoning. Reduced secondary poisoning risk. Very low risk to raptors. Cheaper than second generation anticoagulants. Antidote available. Insoluble in water.	Low toxicity (requires rats to consume more, i.e. more visits to bait stations and more chance for rats to avoid devices). Multiple feed. Large quantity required. Repeated applications required. Longer access to bait required. Non-target species have longer to access bait (i.e., competition with rats). Low persistence .(metabolised quickly).	Not recommended

Toxin	Advantages	Disadvantages	Outcome
		Resistance issues.	
Coumatetralyl.	Moderate toxicity (higher than warfarin). Delayed onset of symptoms (i.e., prevents neophobia and bait shyness). Less persistent than second generation anticoagulants; thereby minimising risk to the environment. Quickly metabolised by rats presenting reduced secondary poisoning risk to scavenging gulls, skuas and birds of prey. Cheaper than second generation anticoagulants. Antidote available.	Moderate toxicity (lower than second generation). Multiple feed. Repeated applications required. Longer access to bait required. Non-target species have longer to access bait (i.e. competition with rats). Few successful island-wide eradications.	Recommended as a primary option. (subject to pre-eradication field study palatability, resistance and efficacy trials).
Second-generation			
Difenacoum.	Moderately to highly toxic. Single feed. Delayed onset of symptoms. Effective on rats. Antidote available (but long-term treatment required). Insoluble in water. Previously successfully used in UK eradications.	Persistence issues (> 9 months in some species). High secondary poisoning risks. Limited data on non-target impacts. Slightly less potent than bromadiolone.	No advantages over bromadiolone as a back up to coumatetralyl.
Bromadiolone.	Single feed. Delayed onset of symptoms.	Persistence issues (> 9 months in some species).	Recommended as a possible back up to coumatetralyl

Toxin	Advantages	Disadvantages	Outcome
	Effective on rats (*Rattus norvegicus* in particular). Antidote available. Not readily soluble in water. Previously successfully used in UK eradications.	High secondary poisoning risks. Some resistance issues suspected. Limited data on non-target impacts.	(subject to pre-eradication field study palatability, resistance and efficacy trials).

6.4 Recommended Toxin

All anticoagulants work in two, different, ways. As 'acute' poisons when the rats eat enough in a single feed to reach the lethal dose, but also as 'chronic' poisons, where small amounts are eaten over several days, resulting in a cumulative dose which is usually less than that needed in a single feed to achieve the lethal dose. Second generation rodenticides such as bromadiolone are regarded as the most potent, but only as 'acute' poisons. However, most rats will only take small nibbles from any new food source. Like most anticoagulants coumatetralyl works best as a 'multi-feed' bait and it is as potent as bromadiolone based bait when taken in this way.

The primary toxin recommended to be used during the eradication programme on Handa Island, its islets, sea stacks and the mainland buffer control zone would be coumatetralyl with bromadiolone probably used as a back-up towards the end of the baiting phase.

As noted in Table 5, **Coumatetralyl** is a first-generation anticoagulant which also acts by reducing the animal's ability to coagulate blood. Death usually occurs with five to ten days after consuming a lethal dose (Eason & Wickstrom, 2001). It is important to note that research has shown rats can survive large single doses (50 mg/kg) but cannot survive multiple doses (1 mg/kg over 5 days; Eason & Wickstrom, 2001).

Coumatetralyl is rapidly metabolised in rats, and in the unlikely event their bodies are then eaten by predators or scavengers such as overwintering gulls or inquisitive birds of prey, there is very little likelihood that they will be adversely affected. It is also important to note that since the baiting phase will be implemented over the winter months nesting skuas are absent and therefore the risk of a skua disturbing a bait station or scavenging on a dead rat is negligible. This assessment supports the EIA[5] and confirms that the magnitude of the effect is considered negligible, and sensitivity is negligible to low. This results in negligible adverse effect, which is considered not significant.

[5] EOR0766_Berwick Bank Wind Farm Application - 6. Derogation Case - Environmental Impact Assessment Report

The formulation recommended for the eradication project is Romax ® Rat CP which is a ready-to-use bait, based on 100g 'soft blocks'. The soft blocks are based on vegetable fats and carbohydrates which exceptionally attractive to rats, especially when other food sources are scare, and temperatures are cold. This results in extremely rapid and high acceptance of the bait.

As noted above **Bromadiolone** is a second-generation anticoagulant poison that act by reducing the animal's ability to coagulate blood, i.e., inhibits the synthesis of Vitamin K and as a result rats and mice die of internal haemorrhaging (Eason & Wickstrom, 2001). This toxin was developed after rats developed resistance to first-generation poisons such as warfarin (Bull, 1976; Eason & Wickstrom, 2001). Death usually occurs between three and ten days after consumption of a lethal dose (LD50, i.e. 50% of test subjects will die from level of poison ingestion) as a result bait shyness is avoided. For a 400 g brown rat, the LD50 for bromadiolone (0.005%) is 12 g of bait. Rats require multiple feeds over several days to obtain a lethal dose.

The antidote for both bromadiolone and coumatetralyl is Vitamin K1, which is available in injection and tablet form from any veterinary clinic. It is recommended that an adequate supply of Vitamin K1 is available throughout the proposed eradication programme.

The selected bait will be distributed at a nominal dose rate of 2.4 kg of bait per hectare per bait round (4 x 100g blocks per bait station) on a 50m x 50m grid. It may require up to 10 rounds of bait in each station to ensure the eradication of all the rats. At this rate, approximately 9,000 kg of bait may be required to cover the island group (approximately 367 Ha) and the mainland buffer control zone (approximately 20 Ha) over the baiting phase of the eradication programme (see also Section 6.6.2) .

6.4.1 Bitrex

Bitrex™ (denatonium benzoate) is a bittering agent added to anticoagulant bait to deter human consumption. It is a legal requirement in the UK that Bitrex™ (or alternative bittering agent) is added to all rodenticides.

Bait containing bittering agents have been used successfully on rat eradications around the world, so the presence of a bittering agent is not expected to be a reason for rats to reject the bait on the Handa Island project, but the operator should be alert to this possibility. It will be important to monitor bait take effectively and relate it to rat sign and activity to be able to assess whether any rats are actively avoiding the bait. Alternative methods (such as trapping, alternative bromadiolone baits, etc.) may have to be used to target these last surviving rats.

6.5 Resistance

Resistance to rodenticides in rats (particularly brown rats) was first detected following long-term use of warfarin in the UK and has now been found in a range of first and second-generation rodenticide around the world, including bromadiolone and difenacoum (Greaves *et al*., 1982; Lund, 1984; Bailey & Eason, 2000; Eason & Wickstrom, 2001; Pelz *et al*., 2005).

Both difenacoum and bromadiolone have evidence of resistance in brown rats in the UK since the 1980's, mainly from urban or farm sites with long histories of baiting (Lund, 1984). Resistance in brown rats has been reported from Wales, southern England, Midlands, and western Scotland (Greaves *et al*., 1982; Lund, 1984; Bailey & Eason, 2000). Most rats that have been found to be resistant to these second-generation anticoagulants were resistant to warfarin recognising the genetically linked relationship, i.e. resistance is transmitted as an autosomal dominant trait (Greaves *et al.,* 1982, Lund, 1984; Pelz *et al*., 2005).

It has also been noted that a higher strength toxin (0.002% rather than 0.0005%) can result in a complete kill of resistant rodents (Lund, 1984; Buckle *et al*., 1994), but this increases the risks to other non-target species and environment. It is important to note that trials have shown that bait attractiveness and uptake may also affect the effectiveness of the baiting regime rather than assuming it is resistance to the toxin (Quy *et al*., 1992).

We understand there is no evidence of rats from Handa Island tested so far showing resistance to rodenticides previously used. This said, during the pre-eradication operational field study (Section 3.3) samples of rat tissues from both island and mainland rat populations will be tested for resistance and this information will inform the final design of the eradication project.

6.6 APPLICATION METHOD

It is recommended that the eradication programme on the Handa is a ground-based operation using bait stations.

The use of bait stations will reduce the impact (and unnecessary mortality) on non-target species, reduce the amount of bait in the environment, will ensure that all bait is accounted for, and bait take (and consumption) by rats can be recorded. Each bait station should have an individual number, plotted using GPS and all data put into a GIS-linked database. Bait take should be recorded in the field via a database app.

It is important to note that although the use of bait stations reduces the risk to non-target species, despite all preventative methods it is possible that some incidental loss to non-target species may occur. However, this small risk should be balanced against the long-term benefits to native species and ecosystem recovery.

6.6.1 Bait station design

Bait stations must allow ready access for rats to the bait but must also prevent entry by key non-target species (such as gulls and skuas).

The recommended bait station design is the nova coil version (Figure 17). These are made from 750 mm lengths (100 mm diameter) of corrugated plastic drainage pipes, with wire "legs" to peg them to the ground to prevent movement by animals and/or wind. Additional wires are pushed through both entrances to limit the size of the entrance and further secure the station. Bait is held in the centre of the station by two wires set low in the station. Both entrances are lifted slightly off the ground (using the curve of the tube) to deter entry by smaller insects. Access to the bait station to replace and monitor bait is via the small hole cut in the top, which is covered with an additional short section of pipe. The lid is held in place by another piece of wire - a ‘crow clip’ devised during the Lundy Island eradication programme (Bell *et al*., 2019) which makes the stations more secure in the wind and stops stock, crows and gulls removing the lids. This bait station design is well proven in a number of eradication programmes around the world, including on Ramsey, Lundy, Isle of Canna, St Agnes & Gugh and Shiants (Bell *et al*., 2011; Bell *et al*., 2019).

Figure 17. Recommended bait station design for the brown rat eradication.

Note: removable inspection lid open to show access hole to reach bait. Bait wired into station and ‘crow clip’ not shown in this image.

Alternatively, commercially available bait stations could also be used (Figure 18). The advantages of these stations is they can be secured (lockable) and as such a number of these stations should be used around public areas. However, unit cost for these stations are much higher than the nova coil design. Rats may also prefer the wider less restrictive entrances to the nova coil stations compared to the smaller entrances on the commercial bait stations, albeit this also does allow the nova coil stations to be more vulnerable to access by non-target species.

Figure 18. Alternative commercial lockable bait station design (shown open).

Wooden bait stations and/or rodent motels may also be needed for permanent locations (such as high risk areas like the Tarbet jetty for long-term biosecurity (Figure 19). These rodent motel and permanent bait station devices can be discretely located in the Handa islands group to ensure the aesthetics of the island are maintained while still ensuring biosecurity.

Figure 19. Example of wooden bait station (left) and rodent motel (right) recommended for permanent locations (pictures courtesy of E. Bell, WMIL).

Note: these wooden stations can be used as a trap station or as a bait station or monitoring station. Bait can be placed in the centre of the box (on the raised central block). Bait can be secured into the station by large nails or wires.

6.6.2 Bait station grid density

The key to the success of the eradication project is the spacing of the bait station grid. On Handa Island the bait stations will be established on a 50m x 50m grid and on the island's stacks and islets it will be established on a 25m x 25m grid requiring a total number of approximately 1800 bait stations to cover the island area of approximately 367 Ha.

In Section 7.1 it is noted that Handa Island and its various islets and sea stacks lie within the 500m 'known' swimming distance for brown rats which means rats could potentially swim between these various aspects. All aspects are therefore considered vulnerable to reinvasion following a rat eradication and will need to be included in the eradication project.

Given the close proximity of Tarbet to Handa Island and its stepping stone islets and stacks, the risk of reinvasion will be mitigated by the inclusion of a rat free buffer control and monitored zone on the mainland. It is recommended that the intensive baiting programme is extended to include a 20 Ha area around Tarbet where rats are likely to be most active alongside human habitation, waste storage and ferry activities. In addition post eradication monitoring will extend along a narrow 50m x 3km length of the coastline that lies within the 500m likely swimming distance envelope. This buffer control and monitoring zone will require a total number of approximately 100 additional bait stations to be deployed and managed during the eradication phase.

Additional stations may be needed to target high risk areas and ensure enough coverage on offshore stacks. As previously noted, A24 multi-kill traps will also be deployed at high risk or difficult access sites such as cliffs, stacks, islets and remote sites.

Figure 20. Handa Island and a 500m eradication zone encompassing its islets, stacks and the mainland Tarbet jetty area (yellow envelope), and a narrow 3 km biosecurity zone on the mainland to be monitored post eradication. (purple line).

It is important that bait stations are placed on all offshore islets and stacks which have vegetation, or which are connected to the main islands. Bait stations in areas with difficult access (such as the coastal cliffs) will be loaded with more bait and may not be checked daily, but rather when weather conditions suit.

The coastlines and coastal cliffs of Handa and all the offshore islets and stacks will also have a line of bait stations. There are a number of technical difficulties on Handa itself, as well as some of the larger offshore islets and stacks. There are steep cliffs and specialised rope access personnel will also be needed to safely access the coastal slopes to place and maintain the bait station and monitoring network. Shore access will also be needed to get into certain areas.

Access to all islands, islets, and stacks in the group and all property on the islands will be requested. It is important that the operational team work with the key stakeholders and Tarbet community to ensure access to all sites is possible.

Special care needs to be given to archaeological areas and sites during the eradication. Whenever possible, bait stations should be placed outside of any recognisable structure and if this is not possible, the required stations should be placed in areas that would minimise disturbance or damage to the site.

In all areas, marker poles and/or flagging tape will aid the location of lines and stations. Each station will be individually numbered, have its position recorded using GPS and added into a GIS-linked database. Maps will be produced of the bait station grid for all phases of the operation. Any gaps in the grid can be detected and corrected prior to the poisoning phase.

It will be important to have a number of spare bait stations and a contingency supply of bait on hand to fill any gaps and cover any damage or losses due to weather.

Once all the bait stations are in position, they shall be left for one week or more (without toxin in them) so the rats become accustomed to them and accept them as part of the terrain.

6.7 Eradication phase

The plan shall be to check bait stations a minimum of every two days, where safe access is available; replacing bait as rats consume it. Partially eaten bait will be replaced with a new block. Old or partially eaten bait will be disposed of at a registered landfill or incineration facility as recommended by the safety data sheets. Where sea conditions and weather forecasts suggest safe access to a location will not be available, larger quantities of bait may be used and/or a greater number of bait stations thereby ensuring bait is still available during periods of no attendance.

Checking bait stations enables constant monitoring of bait take and the resulting die-off of rats. The success of the eradication and any problems, which need to be overcome during the programme, require the detail of accurate recording.

Bait take shall be accurately recorded into GIS-linked database apps in the field for ongoing analysis. Refinements to the eradication phase can be made from this real time data. Hot spots can be identified quickly and targeted throughout the programme.

Baiting should begin in November and continue through to March (overlapping with the early intensive monitoring phase of the programme). Any surviving rats or problem areas should be obvious by the end of December and could be treated with an alternative poison or techniques.

6.8 Intensive monitoring phase

After about six weeks, bait take should be reduced to nil, with all the rats having been poisoned. During the following three months it is vital to establish an intensive monitoring programme on Handa Island and across the mainland buffer zone to detect any rats which may have escaped poisoning. A grid of rat-attractive food items (flavoured wax, soap, chocolate, candles, and apple etc.) as well as chew cards should be pegged out as monitoring tools. Tracking tunnels and trail cameras should also be used.

The coverage of the monitoring grid extends beyond that of the bait stations; one monitoring point at the station and one in-between two stations. Each monitoring site shall be checked every two days to detect rat sign (usually teeth marks or footprints or footage on camera). If any rat sign is detected, an intensive targeting programme (e.g. alternative bait, reduced spacing in the bait station grid, trapping etc.) is started until rat sign in the area ceases.

All intensive monitoring points will be recorded on GPS, entered into the GIS-linked database, and mapped to ensure coverage of the island and mainland biosecurity zone.

It is expected that the monitoring phase of the programme would begin from mid-December. The bait station grid can be removed once the intensive monitoring phase has been completed and rat sign is absent.

If rats are detected at the end of winter (i.e., February and/or March) a second baiting (i.e. during the following winter) and continued monitoring operation would have to be completed to finish the eradication.

6.9 LONG-TERM MONITORING PHASE

Following international best practice, long-term monitoring for surviving (or reinvading) rats continues for two years between the end of the eradication phase before declaring the island rat-free. This is based on the average life expectancy of a wild adult rat (c. 18 months).

The two-year long-term monitoring programme should be continued for at least every four weeks throughout the year to confirm the success of the eradication phase (i.e., to detect any surviving (or possible invasion) of rats). Permanent monitoring stations will be placed around the island (i.e., within known seabird areas, optimum rat habitat and in high-risk areas) to aid with detecting any surviving rats or intercepting invading rats.

Monitoring stations should also be established across the mainland buffer zone, and these will need to be managed over the very long term to ensure any mainland activity can be detected promptly and control actions taken.

All long-term monitoring points should be recorded on GPS, entered into the GIS-linked database, and mapped to ensure coverage of the islands. Any sign or indication of rodents should be photographed and if possible, collected or sampled for expert opinions on identification.

This long-term monitoring for the presence of rodents after an eradication operation is done as part of the biosecurity programme. It is important to monitor using a range of detection devices (such as flavoured and plain wax, chew cards, traps, rodent motels, trail cameras and indicator dogs) and have a regular search effort. Low numbers of rats may take longer to detect than realised. It may also be possible to use the recovery of vulnerable species (such as puffin) or establishment of prospecting species (such as Manx shearwater) to indicate that rats have been successfully eradicated.

Once the two-year monitoring phase has been completed and no rats have been detected, one further intensive island-wide monitoring check is completed. This involves putting a range of monitoring devices over the entire island and checking every two days for six weeks. Once this check is completed and no rats have been detected the island can be declared rat-free.

6.10 TERRAIN AND ACCESSIBILITY

There are no serious problems with accessibility on majority area of Handa island and the mainland biosecurity zone.

The main issue for accessibility will be reaching any of the islets and stacks around Handa which cannot be safely accessed by land. If these islets are only accessible in certain sea conditions this will limit the number of days on which they can be visited. Staff will have to be able to respond quickly to make the most of periods of good weather. Working relationships and safe work procedures will need to be made with a safety and competency approved local boat operator to explore how boat access arrangements would work.

There are a few physical features of Handa Island and the mainland biosecurity zone that pose challenges for an eradication operation, particularly the coastal cliffs and offshore stacks. Sections of the coastal areas will only be accessed by boat or rope. Coastal cliff sections will need specialised rope work to access these areas and suitably qualified and experienced team members will make up part of the project personnel. Access to the offshore islets and stacks will require boat transport and safe egress and operating and emergency response procedures to be developed and implemented for staff working on these more remote and challenging locations. Overall, no topographical characteristics on the Handa islands group are unsurpassable and should not inhibit the success of an eradication programme.

All hazards and mitigation to avoid significant risks will be documented in a series of project specific Risk Assessments and Method Statements (RAMS) with accompanying Safe Work Procedures (SWPs).

6.11 PRE-OPERATIONAL REQUIREMENTS

A number of pre-operational activities shall be completed prior to the proposed eradication phase including, field work to address the uncertainties described in Section 3.3, formal land access agreements formalised, key species monitoring programmes in place, engagement of an experienced eradication operator, rope access technicians, biosecurity plan, onsite preparations complete, health and safety plan, waste management procedures and purchase of project equipment.

6.12 SUMMARY OF TECHNICAL FEASIBILITY

Table *6* summarises the technical feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 6. Summary of the technical feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Technically feasible	Ground-based bait station operation, augmented with multi catch lethal traps. Registered rodenticide. Range of bait station designs. Potential none target impacts managed 50 x 50 m grid, augmented with 25m x 25m grid on islets and sea stacks. Rope and boat access requirement. Winter operation safely delivered. Intensive monitoring period. Biosecurity buffer control and monitored zone.	Pass.

7.0 SUSTAINABILITY FEASIBILITY

7.1 REINVASION POTENTIAL

There are a number of ways a rat can reach an island; these include swimming from neighbouring islands or the mainland, accidental transport in visiting vessels, accidental transport by visitors (in luggage and supplies) or intentional release.

7.1.1 Swimming

Brown rats can swim better than black rats. It is recognised that at 500m a determined brown rat could, subject to sympathetic sea temperature, tide, current and wave height theoretically swim from the mainland to an Island and/ or between an island and its associated islets and sea stacks[6] (Thomas *et al*., 2017). If the distance is twice the currently known swimming distance (so 1000m), invasion by swimming may not occur but it is not considered impossible.

Figure 21 shows two envelopes around Handa Island and its islets and sea stacks that illustrates a known swimming distances of 500 m and a possible distance of 1000m for brown rats.

Handa Island lies approximately 350m distance from the mainland of northwest Scotland and its various islets and sea stacks all lie within 100m of the island. All aspects therefore lie within the 500m 'known' swimming distance for brown rats which means rats could potentially swim between these various aspects. All aspects are therefore considered vulnerable to reinvasion following a rat eradication. Currents, water temperature and marine predators reduce the chances of rats surviving long distance swims (Ershoft, 1954; Evans *et al*., 1978; Duncan *et al*., 2008; Russell *et al*., 2008; Harris *et al*., 2012), but the proximity of Handa Island to the mainland means the risk from incursion by swimming could be considered moderate during summer and autumnal months when sea temperatures reach their maximum. The incursion risk could be managed by good biosecurity, including a mainland buffer control zone (Section 6.6.2).

Because there are a wide range of habitats and food sources on mainland Scotland during the summer and autumnal months, it is also possible that there is little pressure for rats to leave the mainland in favour of Handa Islands following an eradication. This risk can be minimised further by the inclusion of the recommended mainland control and monitoring buffer zone (See Section 3.3 and 6.6).

6 https://biosecurityforlife.org.uk/resources/detail/uk-rodent-eradication-best-practice-toolkit /Annex 4 Biosecurity Planning

Figure 21. Known and possible swimming distances for brown rats (yellow = 500 m and red = 1000m) for the Handa islands group.

It will be important to maintain a robust biosecurity strategy on Handa Island following an eradication operation to ensure any incursions are quickly detected and immediate management action can be taken.

7.1.2 Vessels and visitors

Handa Island has a regular intake of tourists throughout the year, peaking in the period March through August. Information about the eradication should be available on the island during the winter operation (i.e. information panel on shore, brochures in accommodation providers and tourism ventures, etc.).

It is important that an information campaign (such as links to websites, programme leaflets and posters) regarding the eradication programme will be provided to any tourist. Information could be included on Handa-related and SWT websites and provided to boat operators. Given tourists visit Handa over the summer months to view the scenery and enjoy the wildlife, the proposed eradication taking place in the winter months is unlikely to impact on tourism. The eradication of rats and subsequent recovery of seabirds and island ecosystems could have a positive spin off for the tourism industry; tourists present on Lundy Island during the black and brown rat eradication were supportive of the project and the enhancement of the island and species there (along with a new branding and marketing programme) resulted in increased visitor numbers to over 20,000 per year (Khamis, 2011).

As all visiting boats constitute a risk for the re-introduction of rodents (however small), it is important that the eradication programme is discussed with boat operators as well as many regular visitors as possible. An information campaign (such as programme leaflets and posters) regarding the proposed eradication programme could outline the best practices for preventing re-invasion. Biosecurity stations would be established on Handa and some of the offshore islets and on the mainland as part of the biosecurity procedures.

After the successful completion of the proposed eradication, leaflets could raise awareness of the rodent-free status of Handa Island, outline best practices for preventing rodent re-invasion and detail how members of the public can assist. Examples of information leaflets produced following similar eradication projects could be obtained from the relevant agencies (e.g. RSPB for Lundy Island and St Agnes & Gugh and the Biosecurity for Life project, and National Trust of Scotland for Isle of Canna).

7.1.3 Intentional release

Although there is always a possibility that an intentional release (i.e. to deliberately sabotage the eradication) may occur, it is unlikely if the landowners, local community, and relevant agencies support the programme. It is important to continue to include and consult with the landowners and stakeholders in all stages of the project to ensure that everyone takes ownership of the project and sees the benefits for the conservation and ecosystem of Handa Island.

7.2 BIOSECURITY

Once the brown rats have been successfully eradicated from Handa Island and its islets and sea stacks, and controlled in the mainland buffer zone, the priority is to ensure that they do not become re-established on the islands. An effective biosecurity plan will need to be developed and implemented prior to the eradication phase of the programme. This biosecurity plan should also include information on invertebrate and plant pests, parasites and diseases and protocols for Handa Island.

A biosecurity plan would provide details to minimise the risk of accidental liberation of rodents, and what measures should be taken if a rodent is sighted on the island or in the mainland buffer zone.

It is important to be able to distinguish between the failure of the eradication and a biosecurity failure should rodents be detected during the long-term monitoring. DNA samples of brown rats from Handa Island and the mainland buffer zone will be taken during the pre-eradication operational field studies (Section 3.3).

As the Handa islands group and the stepping stone islets lies within the likely (and maximum potential) swimming range of brown rats, biosecurity needs to be maintained over the long term. It will be important to train the key community and local SWT staff of any other relevant agencies and key stakeholders as well as key landowners to ensure that the biosecurity can be undertaken by these groups in the long-term. Data collection and management is important (particularly if incursions are detected and subsequently eradicated); all sightings and other rodent-related observations should be recorded and investigated.

The early interception of incursions is vital, and it is recommended that surveillance (using rodent motels, traps, tracking tunnels, etc.) is undertaken every month. Any rodent caught in a trap should be sent for DNA sampling for comparison against the baseline to determine provenance (i.e. failure of eradication programme or incursion from the mainland). Protocols can be established during the eradication and training given to local agency staff, landowners, and the community to undertake this work long-term.

Periodic audits and on-going monitoring of these biosecurity measures should be completed to ensure compliance and support as it is common for people and agencies to become complacent and have standards drop. It is important that all involved realise that biosecurity is a long-term ongoing commitment.

It will be important to focus on advocacy and education regarding biosecurity protocols and methods as this will engage the stakeholder groups to take ownership of keeping the Handa islands group rat-free.

7.3 Summary of Sustainable Feasibility

Table 7 summarises the sustainable feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 7. Summary of the sustainable feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Sustainable	Within the known (recorded) swimming distance of brown rats. High numbers of visitors throughout the year. Private and charter vessels and operating year-round but peaking in the summer months. Commitment for comprehensive biosecurity programme required from key stakeholders including Scourie Estate, SWT, Tarbet community, and boat operators.	There has been positive engagement with key stakeholders to date. No reason at present to consider that commitment to a robust biosecurity plan would not be forthcoming. A clarification note shall be provided once consultation has been completed.

8.0 LEGAL AND POLITICAL ACCEPTABILITY

8.1 LEGAL AND POLITICAL FRAMEWORK

A number of legal requirements will need to be assessed prior to the operational phase of the proposed eradication. These include, but are not limited to SWT permissions, Scourie Estates permissions, NatureScot permissions and confirmation the implementation plan is valid under Health and Safety at Work and legislation controlling pesticides and pest control.

Similar projects in the UK have met with no significant political or legal issues which would prevent their delivery.

8.2 SUMMARY OF LEGAL AND POLITICAL FEASIBILITY

Table 8 summarises the legal and political feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 8. Summary of the legal and political feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Politically acceptable	A successful project will require the support of the Scottish Government, Highlands and Islands Council, the SWT, NatureScot and other key stakeholders for a brown rat eradication.	No reason at present to believe that eradication would not be politically acceptable. A clarification note shall be provided once consultation has been completed.
Legally acceptable	Registered rodenticide use in bait stations as per relevant UK or local regulations. Working under current health, safety and welfare law and regulations.	Pass.

9.0 SOCIAL ACCEPTABILITY

9.1 INTRODUCTION

Social acceptability is unlikely to be a significant problem for the proposed project. There is a strong case for the environmental benefits likely to follow any proposed rat eradication, particularly in relation to the likely benefits to seabirds. The support of the islands' owners (Scourie Estates) and the nature reserve manager (SWT) and the owner(s) of the large landholding that lies within the mainland buffer zone will be confirmed. But individual residents on the mainland, although they should be kept informed and involved wherever possible, need not give their consent for the project to proceed. The project will, however, need to build and maintain a considerable level of local and regional community support and goodwill to operate effectively.

Safety of residents on the mainland (especially children), domestic animals and wildlife must be paramount, and meetings will need to be held with local residents in order to explain the project methods, the safety measures in place and to discuss any concerns. Residents within the wider regional area are also likely to be interested in the project and should be kept informed. It will be necessary to hold at least one public meeting on the mainland, and to give interviews/ press releases to local news outlets.

Gaining social acceptability therefore depends upon:

- Communicating that risks to island residents and visitors, particularly children, will be extremely low.
- Communicating how risks to non-target wildlife can be managed to an acceptably low level.
- Managing impacts on residents' daily lives – e.g. placing and checking bait stations in homes that lie within the mainland buffer zone, providing rodent-proof rubbish/ compost bins.

These issues have all been raised on other rat eradication project on inhabited islands e.g. Lundy, Canna and St Agnes & Gugh and were all mitigated successfully during those projects.

9.2 SUMMARY OF SOCIAL FEASIBILITY

Table 9 summarises the social acceptability feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 9. Summary of social acceptability feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Socially acceptable	Local stakeholder engagement plan to be developed and implemented during a pre eradication operation phase of work.	No reason at present to believe that eradication

	No major objections are anticipated. Key elements of this plan shall include: • Understanding of eradication requirements (i.e. risk, mitigation for non-target species, etc.). • Understanding of impacts of brown rats on seabirds on the Handa islands group. • Biosecurity strategy understood, including the need for a biosecurity buffer zone on the mainland. • Local concerns have been captured and mitigation measures have been presented.	would not be acceptable to local stakeholders. A clarification note shall be provided once consultation has been completed.

10.0 ENVIRONMENT, HEALTH, AND SAFETY ACCEPTABILITY

The eradication of rats is likely to have a strong positive impact on the wildlife of Handa. Predation on seabirds, as well as many other native plant and animal species will be reduced, allowing populations of these species to recover and expand. A summary of the likely risks to non-target species, and the measures that should be taken to minimise these risks is discussed in this section.

10.1 RODENTICIDE USE

Environmental contamination by coumatetralyl and/or bromadiolone can be minimised by the use of well-constructed bait stations and wiring the bait into the stations. In most cases, traces of poison are only recorded at the entrances of the bait stations. Bait stations should not be placed directly next to water sources or dropped into the sea.

Both coumatetralyl and bromadiolone are unlikely to be found in water as they are not very soluble in water and as such, does not migrate through the soil (Eason & Wickstrom, 2001). Where baits disintegrate, they would most likely remain in the soil, where they may persist for up to a year before being degraded by soil micro-organisms (Eason & Wickstrom, 2001). Relatively persistent in the systems of animals and humans, bromadiolone (170-250 days) and slightly persistent coumatetralyl (55 days) are both slowly excreted in urine (Eason & Wickstrom, 2001). Bait remnants must be disposed at a registered landfill or incineration.

10.2 NON-TARGET SPECIES

Any eradication 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, or secondary poisoning by eating poisoned animals, or indirect effects (such as trampling and disturbance). Programme planning must identify species at risk and establish preventative measures to minimise risk.

There is also the potential for unintended ecological consequences of rat removal, as their loss will affect species which predate upon them, species which are predated upon by them, and species which compete with them for resources. At first consideration, there are no species Handa which would be negatively impacted by the loss of invasive rodents. The most likely visible impact, in addition to a likely increase in bird numbers, is an increase in the rabbit population, meaning that more frequent control may be needed in the future. The risks to non-target species will need to be assessed fully as part of the eradication planning process but it appears at this stage that the main risks are likely to be to wintering gulls, birds of prey and scavenging corvids, particularly crows and ravens.

On Handa Island, its islets and sea stacks and adjacent mainland buffer zone, a range of species are potentially at risk from primary and secondary poisoning and the details of risk and mitigation are outlined in Table 10. Each species (or group) is considered below. The principal preventative action for primary poisoning (i.e. direct consumption of bait) is the design of bait station which excludes larger non-target species.

Table 10. Risk assessment for non-target species during the proposed brown rat eradication.

Species	Effect	Preventative action	Residual Risk after preventative action taken
Plants and fungi	Trampling.	Identification and map locations of rare plants.	Low
Invertebrates	Direct poisoning. Secondary poisoning by eating other invertebrates.	Bait does not affect invertebrates. Bait station design. Bait formulation.	Nil
Marine life (e.g. fish, etc.)	Direct poisoning. Secondary poisoning.	Care to prevent bait falling into sea. Bait only placed in bait stations. Carcasses collected.	Very low
Raptors	Secondary poisoning by eating poisoned rats.	Bait type. Carcasses collected. Timing of eradication.	Medium to Low
Owls	Secondary poisoning by eating poisoned rats.	Bait type. Bait station design. Carcasses collected. Timing of eradication.	Low
Gulls	Direct poisoning. Secondary poisoning by eating poisoned rats.	Bait type. Bait station design. Bait formulation. Bait wired into stations. Carcasses collected.	Low

Species	Effect	Preventative action	Residual Risk after preventative action taken
Crows	Direct poisoning. Secondary poisoning by eating poisoned rats or invertebrates.	Bait type. Bait station design. Bait formulation. Bait wired into stations. Carcasses collected.	Low
Land birds (passerines)	Direct poisoning. Secondary poisoning by eating invertebrates which have consumed bait.	Bait type. Bait station design. Bait wired into station. Carcasses collected.	Low
Seabirds, including skuas.	Disturbance.	Majority of seabirds are not present during winter eradication operation. No footfall shall take place through skua nesting areas during their breeding season, removing any risk of damaging skua nest sites, including their eggs and chicks.	Nil
Bats	Disturbance. Secondary poisoning by eating invertebrates which have consumed bait.	Bait type. Bait station design. Bait wired into station. Carcasses collected.	Low
Stock (cattle, sheep) on mainland buffer zone.	Direct poisoning.	Bait station design. Stock management.	Low

Species	Effect	Preventative action	Residual Risk after preventative action taken
		Adaption of grid if interference noted. Bait formulation. Antidote available.	
Dogs on mainland buffer zone.	Direct poisoning. Secondary poisoning.	Bait station design. Bait formulation. Carcasses collected. Antidote available.	Low
Cats on mainland buffer zone.	Direct poisoning. Secondary poisoning.	Bait station design. Bait formulation. Carcasses collected. Antidote available.	Low
Rabbits	Direct poisoning.	Bait station design.	Low
Wood mice if present.	Direct poisoning. Secondary poisoning.	Bait station design. Bait formulation. Bait station grid network	Low
House mice if present.	Direct poisoning. Secondary poisoning.	Bait station design. Bait formulation. Bait station grid network.	Low
Hedgehogs	Direct poisoning. Secondary poisoning.	Bait station design. Bait station grid network.	Low

The risk of secondary poisoning through eating poisoned rats is low, as most rats die underground or under vegetation in their nests and burrows. Less than five rats were found on the surface in each of the other UK operations on Lundy, Isle of Canna, St Agnes & Gugh and the Shiants (Bell *et al*., 2011; Bell, 2019; Bell *et al*., 2019; Main *et al*., 2019). Searches for carcasses would be undertaken as part of the bait and monitoring station checks as well as along stone walls throughout the eradication project. Any carcasses found on the surface will be collected, necropsied to assess poisoning symptoms, and disposed of safely (by incineration/landfill).

The timing of the eradication, use of bait stations, crow clips, selection of bait type and formulation, and wiring the bait into position reduced the potential risk to non-target species in other UK eradication operations completed on behalf of Natural England, RSPB, NatureScot and The National Trust for Scotland (E. Bell 2019). It is expected that using these same measures, and other adaptions as the operation proceeds, will minimise the potential risk to those non-target species present on Handa.

Despite all preventative methods, it is possible that some incidental loss to non-target species may potentially occur. However, this should be balanced against the long-term benefits to native species and ecosystem recovery.

Through a partnership of agencies, the Campaign for Responsible Rodenticide Use (CRRU) have developed a good practice leaflet on the use of rat poison and the threats to wildlife (CRRU 2021)[7]. This leaflet outlines methods to prevent rodent infestations, methods to control rats, information on trapping, rodenticides and resistance and the dangers to wildlife (particularly raptors and other birds of prey) for the general public.

10.2.1 Plants and fungi

Important plants or fungi should be identified and mapped. These locations should be avoided as much as possible.

10.2.2 Invertebrates

The recommended bait will not affect invertebrates (Booth *et al*., 2001). Centipedes, slugs, beetles, and smaller insects have been recorded eating bait on a number of eradication programmes with no loss. It is more likely that invertebrates that have eaten bait would cause secondary poisoning in other animals which eat them. Following the eradication of brown rats, the populations of large invertebrates are likely to increase with the removal of a major predator, although this increase will be counterbalanced to some extent by rising land bird populations.

10.2.3 Marine life

It is unlikely that the recommended bait will affect crabs. Pain *et al*. (2000) who tested the effects of brodifacoum on land crabs on Ascension Island found although crabs readily ate the bait, none were killed by the toxin. Low residues were recorded in body flesh, but these were excreted within a month

[7] https://www.thinkwildlife.org/code-of-best-practice/crru-code/

(Pain *et al*., 2000). Similar research by Buckelew *et al*. (2005) and Wegmann *et al*. (2011) during the Palmyra Atoll rat eradication also reported that crabs did not appear to be detrimentally affected by brodifacoum exposure through the consumption of bait. The main problem is that consumption of bait by crabs can affect the availability of bait to rats (Wegmann *et al*., 2011; Keitt *et al*., 2015).

It is also unlikely that the recommended bait will affect other marine species. As shown by an accident in New Zealand in 2001 when significant amounts of brodifacoum bait fell into the sea, residues were detected in shellfish at the 100 m^2 site immediately but this dropped to nothing after several weeks (Primus *et al*., 2005). No observable effects of brodifacoum on marine ecosystems after aerial bait drops using pellet bait have been recorded in New Zealand and fish did not appear to show any interest in the bait (Empson & Miskelly, 1999; Fisher *et al*., 2011). As the bait will be contained in bait stations, it is very unlikely that any bait will make it into the sea. Rat carcasses will be collected and disposed of safely.

10.2.4 Raptors and owls.

Raptors, owls and potentially skuas are at risk from secondary poisoning (from scavenging dead rats or targeting slower sick rats). The risk of secondary poisoning through eating poisoned rats is medium to low, as most rats and mice die underground or under vegetation in their nests or burrows. Few rats were found on the surface during other UK eradications (Bell, 2019).

Searches for carcasses should be undertaken throughout the eradication programme. Any carcasses found on the surface will be collected and disposed of safely.

10.2.6 Crows, wintering gulls and skuas.

Skuas are not considered to be at any risk to the eradication programme as they will not be present on Handa during the winter eradication operation.

Having some fat/ wax content to the formulation, crows (*Corvus* spp.) and gulls (*Larus* spp.) have been recorded eating rodenticide baits during other eradications in the UK (Bell *et al*., 2011; Bell *et al*., 2019; Bell, 2019, Main *et al*., 2019). Crows and gulls may also interfere with the bait stations. Experience on Ramsey Island, Lundy Island and the Isle of Canna has developed an alternative bait station design; a longer bait station, wired entrances and a crow clip were added (Bell, 2019). This made the stations more secure in the wind and stopped the crows and gulls removing the lids (Bell, 2019). Further adaptations can be made throughout the eradication programme if necessary. Consideration will also be given to the use of lockable traditional bait boxes for higher risk areas (see also Section 6.6).

Another risk to gulls, skuas and crows is from eating dead or dying rats. Many gulls and skuas may not be present on the Handa islands group during winter, but as with raptors, this risk is low due to rats dying underground or under vegetation, and the studies preference to use a first generation rodenticide formulation that can be metabolised quickly by the rats leaving minimal rodenticide residues.

Adaptations to the bait stations or bait grid can be made throughout the eradication if interference by gulls is noted.

10.2.7 Other land birds (Passerines)

Grain based baits will not be used for the eradication operation. Fat/ wax based formulations will be less attractive to passerines. Furthermore, the bait will only be delivered in bait stations and most passerine species will not enter a bait station due to fear of predation. The risk to passerines is reduced further by the bait station design (increased length and additional wires) and the fact that the bait is wired into the stations. If passerines are noted interfering with the bait and/or stations throughout the eradication programme, further adaptations can be made as necessary, including changing over to a lockable traditional bait box design.

10.2.8 Bats

Bats are primarily invertebrate foragers. As such it is likely that bats would only be at risk from secondary poisoning via eating invertebrates.

Like many other species there is limited data on the impact of anticoagulant poisons to bats (and no data on the recommended rodenticides coumatetralyl or bromadiolone), but there have been no deaths reported from previous eradication operations in the UK, and bats did not show any interest in pellet or block bait formulations reported on by others (Lloyd, 1994; Eason & Spurr, 1995; Sedgeley & Anderson, 2000; O'Donnell *et al*., 2011).

10.2.9 Dogs and cats

There will be a number of domestic dogs and pet cats on the mainland. Domestic dogs and cats are at low risk from both primary and secondary poisoning. The risk of primary poisoning is very low as the bait is in fat/ wax-block form and on mainland locations it will be presented in secure and lockable bait stations. There is also a very low risk of secondary poisoning from eating dead or dying rats, but as most rats die underground and carcasses will be recovered and disposed of safely, there should be few rats accessible to cats or dogs.

The local veterinarians should have all the relevant information on the poison used, symptoms and treatment prior to the eradication. Vitamin K1 is the antidote to bromadiolone, and it is available in injection or tablet form (requiring 1-5 mg/kg once a day for 1-4 weeks depending on amount of bait consumed). Any dogs or cats accidentally poisoned can be effectively treated either by the veterinarian or trained project personnel.

10.2.10 Rabbits

It is likely that the fat/ wax content in the blocks makes the bait less attractive to rabbits. Furthermore, the bait station design (i.e. long bait station, wired entrances and a crow clip and/or traditional lockable bait box) will prevent the majority of rabbits gaining access to the bait. Juvenile rabbits were still able to squeeze into the bait stations on Lundy Island (E. A. Bell, *pers. obs*., Lock, 2006), but breeding should be over during winter. Further adaptations to the bait station can be made throughout the eradication if necessary.

10.2.12 Wood mice and House mice

Mice if present will be susceptible to the bait and owing to their small size will not be prevented from accessing the bait stations. However, their home range is much smaller than the bait station grid and although a proportion of the mouse population may be affected, the population is likely to recover after the removal of rats. Wood mouse on Isle of Canna recovered quickly after rats were removed (Bell *et al.,* 2011). Mice have often rebounded following the rat eradications as predation pressure has been released (Caut *et al*., 2007; Harper & Cabrera, 2010; Ruscoe *et al*., 2011; Goldwater *et al*., 2012).

10.2.13 Hedgehogs

Hedgehogs are at risk from the grain-based bait, although it is likely that the fat/ wax content in the blocks makes the bait less attractive. They may also be at risk from eating invertebrates that have consumed the bait. However, the bait station design (i.e. long bait station, wired entrances and a crow clip and/or traditional lockable bait stations) will prevent the majority of hedgehogs gaining access to the bait. Further adaptations to the bait station can be made throughout the eradication if necessary.

10.3 Alternative natural food

The eradication plan will schedule the work to take place over the winter period when the natural food supply is most scarce for rats. The rat diet at this time of the year will primarily comprise scavenging vegetation, insects, marine crustaceans, animal and seabird carcasses and human derived waste products. Any animal or seabird carcasses will have to be monitored closely to check for rat activity and removed for disposal.

Guidance will be provided to the SWT and mainland residents to contain food waste to minimise the availability of these wastes to scavenging rats.

As shown by eradication operations on inhabited islands, waste containment may need to be improved across the buffer control zone to minimise access to human-derived food waste by rats. Rat-resistant plastic wheelie bins and compost bins proved successful in excluding rats from human-produced rubbish on the Isles of Scilly during that eradication (Bell *et al*., 2019). Similar options could be implemented across the mainland buffer zone.

10.4 Key species monitoring

Key seabird species monitoring should be undertaken in close consultation and collaboration with the SWT prior to, during and after the proposed eradication. The pre-eradication monitoring can focus on further quantifying the impacts of brown rats and probably other potential predators including hedgehog, mink and stoats to the target seabirds, other birds, invertebrates, plants, and other aspects of Handa Island and the mainland buffer control zone. This monitoring will help to inform the benefits (and identifying any unforeseen negative impacts) of eradicating rats and potentially other predators from these aspects. Monitoring should commence in the spring and summer ahead of a winter eradication to enable additional baseline information to be collected. This monitoring may continue for several years after the eradiation phase. A detailed Key Species Monitoring Plan should be prepared to ensure relevant, robust, and accurate data collection procedures, data storage and analysis.

10.5 HUMAN HEALTH

Direct ingestion of baits or inhalation of bait dust poses a potential health risk with young children being most at risk from ingestion should they obtain access to the bait. This risk shall be mitigated by only dispensing bait using enclosed, locked and secured boxes. Furthermore, the recommended baits for the eradication, Romax Rat CP and Contrac Blocks™ have Bitrex™ added (as per UK regulations). Bitrex™ is a bittering agent to make the bait unattractive to children and adults.

As rodenticide blocks have been recommended, the risk of dust inhalation is reduced. Clear warning signs (detailing the eradication, bait station design and danger from bait) should be placed on Handa Island and the mainland buffer control zone at all public access points and suitable landing sites (quay, beaches, noticeboards, etc.). Warning labels will be placed on all bait stations advising visitors not to touch the stations or bait.

The antidote for anticoagulant poisoning is Vitamin K1. In the unlikely event that a person ingests bait, medical advice and aid should be provided. Diagnostic and treatment procedures should be discussed with a local medical doctor as part of the operational planning process.

A detailed information sheet outlining the hazards associated with coumatetralyl and bromadiolone should be prepared for the eradication team as part of the Health and Safety plan prior to the operation.

Rats are known carriers of a number of diseases (including leptospirosis, toxoplasmosis, salmonella, and cryptosporidium) and parasites (including mites and fleas). Generally, most people catch leptospirosis from drinking contaminated water or handling wet vegetation or soil (that had the bacteria present after being spread in rat urine) and then transmitted via the hands to the mouth (by eating or smoking) rather than handling rats. The risk from leptospirosis is highest in warm, moist environments. The bacterium dies almost immediately when it dries out. Most people are at minimal risk from this disease. There are no reports of leptospirosis (Weil's disease) on Handa. Information on the symptoms and treatment for leptospirosis would be part of the project documentation. Clearly the eradication of rats will remove rat borne diseases across the eradication areas.

As part of the project Health and Safety procedures, to remove any minor risks from handling bait, animal carcasses, or working with and around rats, all eradication team members should be wearing protective gloves and protective clothing (i.e., overalls, boots etc.). Any cuts or abrasions should be covered. It is very important to wash and thoroughly dry hands before eating, drinking, and smoking after handling bait or carcasses. All rats (and other carcasses) should be handled using gloves.

10.6 Health and Safety

The health and safety of the project team is of primary concern. A detailed Health and Safety Plan should be prepared for the project. This must be approved by the project-chartered safety practitioner and relevant organisations prior to the eradication operation. This plan must detail all hazards and mitigation to avoid these issues. The team should be trained in comprehensive outdoor first aid or Pre-Hospital Emergency Care. A member of the team should be designated as the Safety Officer and be responsible for addressing any safety issue that arises during the project. No unsafe practises will be allowed to continue.

There are a few physical features of the project area that pose challenges for an eradication operation, particularly the coastal cliffs and offshore stacks. Sections of the coastal areas will only be accessed by boat or rope. Coastal cliff sections will need specialised rope work to access these areas. This will require suitably qualified and experienced team members as part of the project personnel. Bait stations with difficult access could have more bait placed inside during each check to enable enough bait to be available to rats in these areas.

The offshore islets and stacks will require bait stations and regular checks, and this will require the provision of boat transport and safe egress and operating and emergency response procedures to be developed and implemented for staff working on these more remote and challenging locations.

Overall, no topographical characteristics on Handa Island, its islets , stacks and mainland buffer control zone are unsurpassable and should not inhibit the success of an eradication programme.

10.7 Waste management

It is important that the availability of alternative food for rats is minimised during the eradication programme. Waste management arrangements will be discussed and arranged through Highlands and islands Council, SWT, Scourie Estates, mainland residences and local businesses.

Waste bait, rat carcasses and used monitoring tools should be disposed of at a registered landfill or incineration facility as per regulations.

The eradication project shall also generate its own waste streams including:

<u>Non-hazardous Wastes e.g:</u>

- Packaging waste.
- Used personal protection equipment, gloves, masks, ropes etc.
- Paper waste.
- Food wastes etc.

<u>Hazardous wastes e.g:</u>

- Spent rodenticide bait.
- Contaminated rat carcasses etc.

A project waste management plan (PWMP) shall be developed to identify and document the types of waste that will be produced and describe how they will be handled, from generation to recycle to reuse and/or to disposal, and in accordance with the guidance and standards laid down by the Highlands and Islands Council.

10.8 Archaeology

Rats can have a negative impact on archaeological structures; much of this is due to digging burrows underneath. There may be archaeological sites on Handa island and within the mainland buffer control zone and local landowners, managers and interest groups shall be consulted should there be a requirement to extend the eradication grid to include any sites of potential archaeological significance.

If required and where possible, bait stations should be placed outside of any recognisable structure and if this is not possible, the required stations should be placed in areas that would minimise disturbance or damage to the site.

10.9 Likely outcomes (Cost/Benefit) following the brown rat eradication

There are a number of outcomes that could result following the eradication of brown rats from the Handa islands group. Owing to the number of eradication projects that have occurred around the world, responses of a number of species (i.e. seabirds, land birds, plants, invertebrates, mammals, and reptiles) have been monitored (Towns *et al*., 2006; Witmer *et al*., 2007). Most species have benefited following the eradication of rats, but there have been some unforeseen and negative impacts recorded too (Courchamp *et al*., 2003; Towns *et al*., 2006).

It is recommended that pre- and post-eradication monitoring of target seabirds, and other birds, invertebrates, and vegetation is included in the project. This will help quantify impact on or changes to the status and productivity of these species following the eradication.

It is expected that the following could occur on Handa: (i) guillemot, razorbill, puffins, kittiwake, fulmar, skua and other seabird species present on Handa island will have enhanced breeding success, (ii) prospecting Manx shearwaters may establish new breeding colonies. Establishment techniques, such as playback attraction, burrow provision and translocation, have been used successfully elsewhere, and would greatly improve the prospects of breeding colonies for these species post-eradication (Miskelly *et al.,* 2009), (iii) regeneration of vegetation (such as heather) susceptible to suppression by rats, (iv) enhanced breeding success of land birds such as snipe, pipits, skylarks and twite, and (v) reappearance of rarely seen or unknown invertebrates.

There have been unforeseen and unintended negative consequences following eradication projects around the world, particularly other exotic species (usually plants) have increased (Towns *et al*., 2006). It is possible, but unlikely that the following negative impacts could result following the eradication of rats from the Handa islands group: (i) changes and spread of exotic and problem plant species, (ii) fluctuations in the abundance of invasive invertebrates which could compete with or affect native plant and invertebrate species, (iii) prey switching by other native or non-native predators (i.e. raptors), (iv) rabbit and hedgehog populations increasing.

Monitoring should be conducted during the pre-eradication phase of work to collect baseline information on likely problem species, particularly weeds and invertebrates. It is possible that weed species whose seeds are eaten by rats, may currently be kept at low densities which may cause a problem if weed species spread into vulnerable or important areas. However, many weeds are also spread by rats when they cache fruit and seed. Interestingly the eradication of rats may result in native plants outcompeting some weed species.

Information on the ecology and seabird populations of the Handa islands group has been collected for a long period by various individuals. This project will provide the opportunity to measure the rate of recovery after the eradication of brown rats. The opportunity for seabird restoration on Handa Island post-eradication is good; current seabirds (such as kittiwake, fulmar, skuas puffins, razorbills, and guillemots) could expand range and density and prospecting species could establish on the islands and offshore stacks.

It is important to assess the level of native predators (i.e. raptors and gulls) on the Handa islands group to determine what affect these species may have on the recovery and spread of seabirds on the island. There are few native predators on the Handa islands group, although gulls and raptors are known to predate other bird species. Gull numbers are unlikely to change due to rats being eradicated from the island, as they are not significantly affected by rat predation.

10.10 Summary of Environmental Feasibility

Table 11 summarises the environmental feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 11. Summary of environmental feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Environmentally acceptable	Rodenticide contained in bait stations. Working to strict H&S protocols. Compliant waste management protocols. Key species monitoring to ensure no negative affect from eradication operation. Archaeology mapped to ensure no impact from eradication operation.	Pass.

Feasibility criteria	Summary	Outcome
	Mitigation strategies for non-target species to prevent impact during eradication operation.	

11.0 CAPACITY

11.1 ORGANISATION, LOGISTICS AND RESOURCING PLAN

For any eradication programme on the Handa islands group to be successful it must involve experienced operators. It is a challenging operation and would need a large team of up to 16 specialists to manage around 2000 bait stations across a range of terrain. The specialist skills will include eradication expertise, qualified rope access and boat operations. This level of resource will enable the grid to be established in the recommended timeframe, as well as ensuring that Handa Island, its islets sea stacks and the mainland buffer control zone can be baited, monitored, and checked every two days as required.

This field team would be supported by a mainland-based management and communications team to help plan, coordinate, direct staff and maintain effective communication with the SWT, landowners, relevant government, and non-government agency personnel, interested parties and stakeholders.

The team leads would need to be involved in all stages of the preparation and implementation of the eradication programme, including attending project planning meetings, maintaining communication between the stakeholders, obtaining equipment, and coordinating field activities. This lead team would have to be involved throughout the lead-in time (6-12 months prior) as well as the six-month eradication operation. The remaining field team would be involved for the implementation stage (6-month eradication).

Boat transport with crew transfer capability would be required. This could be via a charter operator or purchasing a project boat with a qualified and experienced boat operator as part of the team. The eradication on the Handa islands group is reliant on boat transport around the coast of the main island as well as the safe transfer on and off the offshore islets and some cliff or coastal areas. Boat transport could be affected by adverse weather or availability of a suitable vessel. It will be vital that a boat is confirmed for the duration of the project.

In addition to the experienced eradication operators, it is recommended that wherever possible, local, or regional agency staff and local community members will be trained to enable the long-term monitoring to be undertaken by these people or agencies.

11.2 SUMMARY OF CAPACITY FEASIBILITY

Table *12* summarises the capacity feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 12. Summary of capacity feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Capacity	Project leadership, direction and health and safety. 16-person eradication team (including rope access personnel). Boat transport around and to islands in the Handa islands group. Operational base on Handa for project team. Agency support for ongoing biosecurity.	Pass.

12.0 FINANCIAL VIABILITY

12.1 COST ESTIMATE

Costs are being developed to deliver the eradication project, carry out the monitoring and establish the long term biosecurity programme for the life span of the Berwick Bank Wind Farm.

A contingency sum shall be built into the budget to allow for the possibility of rats being detected at the end of the eradication phase or aspects of the project go over the allocated time. This allows for a second baiting operation (i.e., during the following winter as it is more difficult to target rats successfully during spring and summer when natural food is widely available) to complete the eradication programme. Although, based on similar eradication projects in the UK this should not be necessary, it is important to plan for every outcome.

12.2 SUMMARY OF FINANCIAL FEASIBILITY

Table 13 summarises the financial feasibility criteria. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 13. Summary of financial feasibility criteria for the proposed brown rat eradication.

Feasibility criteria	Summary	Outcome
Affordable	Two-year eradication operation. Biosecurity and adaptive management and stakeholder engagement would continue.	Pass

13.0 CONCLUSIONS

Berwick Bank identified an opportunity to eradicate mammalian predators on Handa Island as part of the suite of compensation measures if required. Handa Island was chosen based on delivery and connectivity of the seabird populations within a wider geographical network within the area.

The feasibility report has found the eradication of brown rats (*Rattus norvegicus*) from Handa Island, its islets and sea stacks followed by on-going biosecurity monitoring and control on the adjacent mainland is feasible. A comprehensive, rat eradication and biosecurity operation that follows international best practice (Clout & Williams, 2009; Thomas *et al*., 2017) should be adopted, with clear strategies in place to deal with risk and technical requirements to maximise the likelihood of success. Unobtrusive biosecurity measures will help reduce re-introduction risk. There would be significant benefits to the seabirds including kittiwake, guillemot, razorbill and puffin following rat eradication.

The outcomes of the study against the 7 internationally recognised feasibility criteria described in the UK Rodent Eradication Best Practice Toolkit (Thomas *et al*., 2017) are provided in Table 14. Colour coding represents Green as Criteria met; Amber as Criteria requires further study or consultation and Red as Criteria not met (fail).

Table 14. Summary of feasibility assessment outcomes for Handa Island.

Feasibility criteria	Summary	Outcome
Technically feasible	Ground-based bait station operation, augmented with multi catch lethal traps. Registered rodenticide. Range of bait station designs. Potential none target impacts managed 50 x 50 m grid, augmented with 25m x 25m grid on islets and sea stacks. Rope and boat access requirement. Winter operation safely delivered. Intensive monitoring period. Biosecurity buffer control and monitored zone.	Pass.
Sustainable	Within the known (recorded) swimming distance of brown rats.	There has been positive engagement with key stakeholders to date. No reason

Feasibility criteria	Summary	Outcome
	High numbers of visitors throughout the year. Private and charter vessels and operating year-round but peaking in the summer months. Commitment for comprehensive biosecurity programme required from key stakeholders including Scourie Estate, SWT, Tarbet community, and boat operators.	at present to consider that commitment to a robust biosecurity plan would not be forthcoming. A clarification note shall be provided once consultation has been completed.
Politically acceptable	A successful project will require the support of the Scottish Government, Highlands and Islands Council, the SWT, NatureScot and other key stakeholders for a brown rat eradication.	No reason at present to believe that eradication would not be politically acceptable. A clarification note shall be provided once consultation has been completed.
Legally acceptable	Registered rodenticide use in bait stations as per relevant UK or local regulations. Working under current health, safety and welfare law and regulations.	Pass.
Socially acceptable	Local stakeholder engagement plan to be developed and implemented during a pre eradication operation phase of work. No major objections are anticipated. Key elements of this plan shall include: • Understanding of eradication requirements (i.e. risk, mitigation for non-target species, etc.). • Understanding of impacts of brown rats on seabirds on the Handa islands group.	No reason at present to believe that eradication would not be acceptable to local stakeholders. A clarification note shall be provided once consultation has been completed.

Feasibility criteria	Summary	Outcome
	• Biosecurity strategy understood, including the need for a biosecurity buffer zone on the mainland. • Local concerns have been captured and mitigation measures have been presented.	
Environmentally acceptable	Rodenticide contained in bait stations. Working to strict H&S protocols. Compliant waste management protocols. Key species monitoring to ensure no negative affect from eradication operation. Archaeology mapped to ensure no impact from eradication operation. Mitigation strategies for non-target species to prevent impact during eradication operation.	Pass.
Capacity	Project leadership, direction and health and safety. 16-person eradication team (including rope access personnel). Boat transport around and to islands in the Handa islands group. Operational base on Handa for project team. Agency support for ongoing biosecurity.	Pass.
Affordable	Two-year eradication operation. Biosecurity and adaptive management and stakeholder engagement would continue.	Pass

To summarise, a well-planned eradication programme managed by experienced operators, adequately funded, and supported by the landowners, community, and stakeholders, would result in the eradication of brown rats from Handa Island and its islets and sea stacks. This would improve the habitat for target seabirds to breed more successfully and for colonies to grow.

To accompany the removal of brown rats from Handa Island, controls must be extended to include a buffer control zone on the mainland, and long term monitoring, biosecurity and response measures must be implemented to prevent re-invasion as part of this compensation package.

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