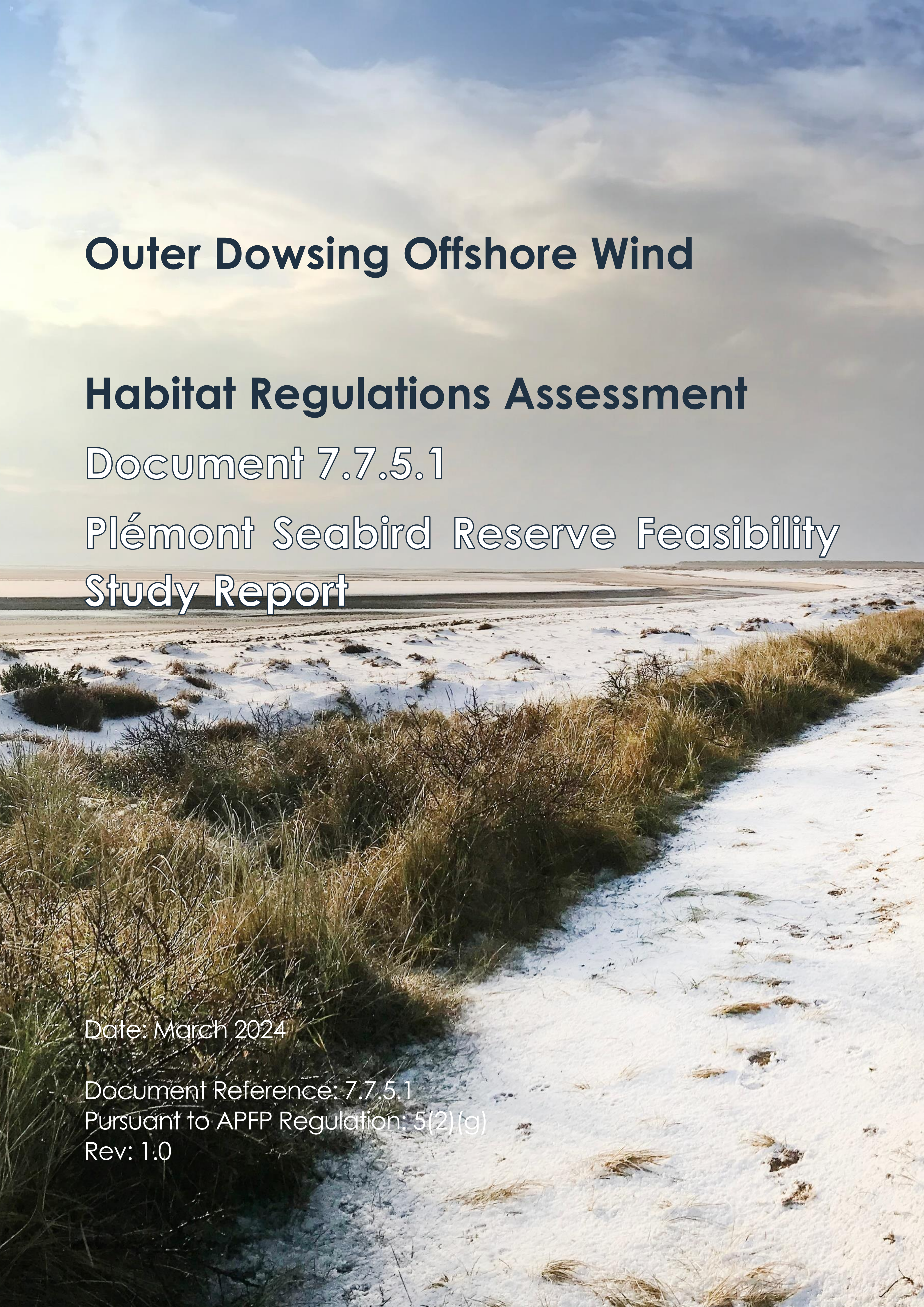

Outer Dowsing Offshore Wind

Habitat Regulations Assessment

Document 7.7.5.1

Plémont Seabird Reserve Feasibility Study Report

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PLÉMONT SEABIRD RESERVE

FEASIBILITY STUDY REPORT FOR A PREDATOR-EXCLUSION FENCE

Cristina Sellarés de Pedro

2021

National Trust Jersey

ROY OVERLAND CHARITABLE TRUST

BIRDS ON THE EDGE

PLÉMONT SEABIRD RESERVE

FEASIBILITY STUDY REPORT FOR A PREDATOR-EXCLUSION FENCE

Cristina Sellarés de Pedro

Birds On The Edge

This report was prepared for the Birds On The Edge partnership as part of the duties of the project officer.

Partners:

The National Trust for Jersey

Durrell Wildlife Conservation Trust

Government of Jersey Natural Environment Department

Jersey

February 2021

EXECUTIVE SUMMARY

This report assesses the justification for and feasibility of creating the Plémont Seabird Reserve with the erection of a predator-proof fence around the puffin nesting site, and the eradication of all invasive predators from within. The reserve will be located between the Plémont headland and Grève de Lecq bay, where most of the land is managed by Jersey's Natural Environment Department.

The results of two years of ecological research in the area, as well as an examination of historical bird records, have determined the critical situation of the puffin population in Jersey, standing at four confirmed pairs in 2020. The razorbills fare only slightly better at an estimate of six to eight pairs, and there are no guillemots breeding in Jersey. These three related species of auk used to be found in large colonies in this area in the early 1910s, with 200-300 breeding pairs each. It is believed that their dramatic decline and local extinction over the last century was caused by a combination of predation from introduced mammals and the encroachment of bracken on their grassland habitats.

The Jersey puffins are not nesting in their typical setting of burrows in coastal grassy slopes, but instead are nesting below the vegetation line, on almost-vertical cliffs, in rock crevices, between boulders, and under rocky outcrops. This is probably a result of historical predation and the present effect of invasive predators, which have been found on the slopes above the cliffs. The surveys revealed the presence of four species of invasive mammalian predator in the coastal slopes, namely brown rat, feral ferret, cat and European hedgehog. All are known to predate on adults, chicks or eggs of ground-nesting seabirds in other parts of the world, including various offshore British islands.

The surveys also revealed small populations of other native wildlife classified as threatened or featured in local biodiversity action plans, such as peregrine falcon, European shag, common stonechat, green lizard, and slow worm, amongst others, making this an area of high conservation potential.

The Birds on the Edge partnership believes that to ensure a future for the puffins in Jersey their habitat must be made safe and suitable, and after analyzing the existing management options, this assessment concludes that the most cost-effective and environmentally acceptable solution is to create a Seabird Reserve where the present colony is, to protect it with a predator-proof fence, and to remove any invasive predators found within it. A number of predator-exclusion fences have been established around the world, creating wildlife reserves as 'mainland islands'. Once the fence is completed, the invasive species inside the enclosed area can then be eradicated or relocated using similar methods as the ones used on offshore islands.

Installation of the predator-exclusion fence at the site appears technically feasible, and despite some challenges such as steep rocky cliffs, there is local expertise from geoengineering contractors which have done works in similar conditions.

Based on current available techniques and the small size of the proposed site, removal of the invasive predators from the reserve is feasible, with increased chances of success if all four species are targeted at once using a combination of methods. Eradications of a wide range of invasive mammals have been successful in fenced reserves and offshore islands in several countries. Their positive environmental impact is well documented as well methods available to minimise any potential negative effects on non-target species, which are usually short-termed. This work has the support from local wildlife and animal welfare agencies, which will assist with technical advice and take responsibility of feral animals removed from the reserve. The potential for re-invasion will be dependent on the final design of the fence as well as the robustness of the monitoring and bio-security measures put in place.

The fence will have other positive effects for the area's biodiversity by facilitating habitat management works, such as bracken removal and the use of a grazing flock. The removal of invasive predators will potentially result in increased populations of native land birds, reptiles and small mammals, which would otherwise be kept at low densities or eventually extirpated by the invasive predators.

A consultation process has begun and key stakeholders have been identified, however further work will be needed to engage the local community and encourage participation in the decision-making process. This will ensure the continuity and long-term success of this project. Some potential concerns raised by the site users are likely to be related to visual impact and accessibility; these issues should be addressed with the right positioning and landscaping of the fence, as well as the provision of access gates at strategic points.

The benefits of this project to the Island community relate to the enhancement of the natural value of this popular site, and thus promoting physical and mental wellbeing. The project will also generate economic benefits in the form of local employment, training apprenticeships, research opportunities for local students, and increased business in the tourism and hospitality sectors.

The proposed fence will have a maximum approximate length of 2,938 metres and protect 32.3 hectares of land. Conservation fences are expensive projects and the total cost of this fence is estimated at 879,921GBP. The costs of eradication works will be in comparison much lower, but the fence will require long-term maintenance and bio-security measures to prevent re-invasions. It is important to have a clear plan for financing the initial works and the long-term management before embarking on this project.

In summary:

1. The most effective way to ensure the future of the puffins in Jersey is to create a predator-proof fence around their nesting site and to remove all invasive predators from within. The creation of the Plémont Seabird Reserve will also benefit other native species present at the site as well as the plant community and habitats.

2. The Plémont Seabird Reserve will benefit the local community and users of this area with an enhancement of the natural habitats and wildlife at the site, promoting well-being and awareness for conservation of nature. The project will also generate economic benefits for various sectors as well as training and educational opportunities.

3. Based on available techniques developed in similar projects, the installation of the fence and the eradication of invasive predators are technically feasible. This project will require a fence design specialist, high quality materials, detailed operational plans, environmental risk assessments, a robust biosecurity strategy, and a far-reaching public engagement and awareness plan, in order to secure the support of the local community and the key stakeholders.

4. The fence is estimated to be approximately 2,938m long and will protect 32.3ha, costing an estimate 879,921GBP. There will be ongoing costs, albeit significantly lower, as the fence will require maintenance and long-term biosecurity measures.

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ACKNOWLEDGEMENTS

This work was carried out for the Birds On The Edge partnership as part of the "Plémont Seabird Reserve project". The partnership is a joint initiative between The National Trust for Jersey, Durrell Wildlife Conservation Trust and the Government of Jersey's Natural Environment Department. The Roy Overland Charitable Trust provided funding for the role of the Birds On The Edge Project Officer, who carried out the ecological research, feasibility study, and production of this report.

Biz Bell of Wildlife Management International Limited has been the main technical advisor on all aspects of this study, which has adapted material from her publication "*Feasibility Study for a 'mainland island' on Saint Lucia: a pest-proof fence at a mainland site*" (2014).

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1. INTRODUCTION

1.1 Purpose and structure of this report

This feasibility study and report have been produced on behalf of the Birds On The Edge partnership by its project officer Cristina Sellarés de Pedro, who is employed by the National Trust for Jersey with a grant from the Roy Overland Charitable Trust.

The purpose of this feasibility study is to assess the feasibility of erecting a predator fence near the puffin colony in the north coast of the Island and eradicating all terrestrial invasive predators from inside the fenced area, as well as to evaluate its potential as a measure of long-term protection for the colonies of puffins and other endangered seabirds. The present report addresses three questions: 1) why this needs to be done, 2) whether it can be done, and 3) how it can be done.

The remainder of the Introduction section offers context to the Birds On The Edge partnership and the role of the fence and eradication within the BOTE Plémont Seabird Reserve project, as a summary of key findings of the first two years of this project, the rationale behind the proposal at the centre of the feasibility study, an insight into the feasibility criteria and a guide for the terminology used. Chapters 2, 3 and 4 cover the aims of this work and describe the study area and proposed reserve site, from a natural, historical and cultural perspective. Here are presented the results from various ecological surveys highlighting the status of the puffin colony as well as many other native species in the area. Chapter 5 focuses on the presence and distribution of the four target species, the invasive predators found in the area, with an overview of their known impact on island ecosystems in British Islands and around the world. Chapters 6, 7 and 8 present the feasibility analysis itself, the costs and benefits of alternative management options, and the final conclusions of this report.

This report will be made available on first instance to all relevant Government of Jersey authorities as well as St Ouen's Parish authorities, key stakeholders and affected parties.

1.2 The Birds On The Edge partnership

The Birds On The Edge partnership (BOTE hereafter) is a joint initiative between the National Trust for Jersey, the Government of Jersey Natural Environment Department, and Durrell Wildlife Conservation Trust, which aims to restore Jersey's coastal lands and habitats, in order to enhance local populations of rare or endangered birds.

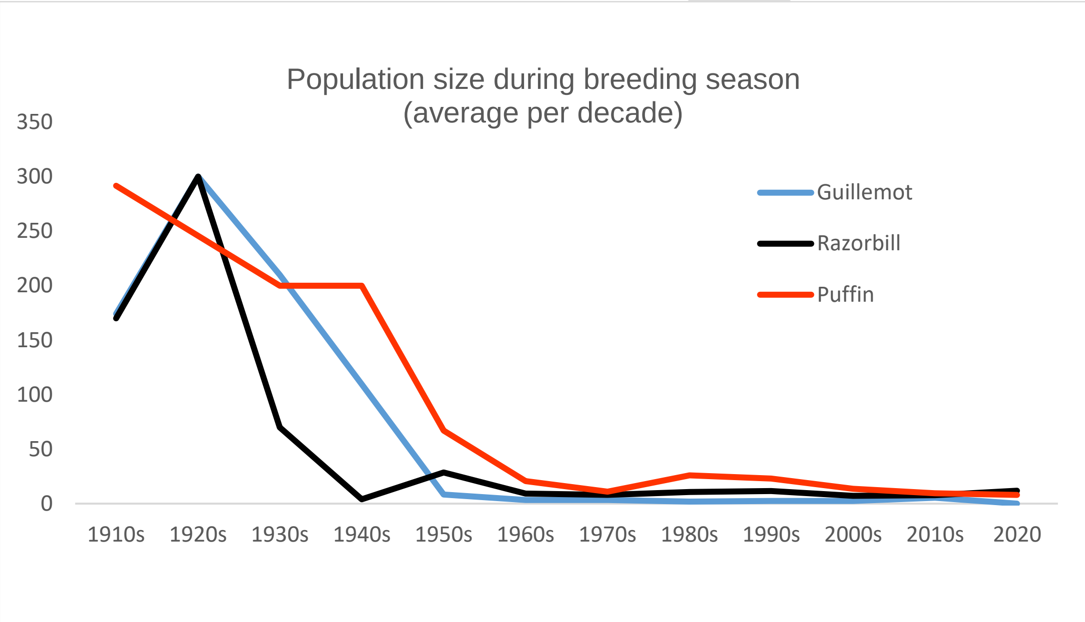
In other to achieve its goals, BOTE works with many local and international organisations such as the Société Jersiaise, the Jersey National Park, the Channel Islands Bird Ringing Scheme (CIBS), the Jersey International Centre for Advanced Studies (JICAS), the Jersey Biodiversity Centre, the British Trust for Ornithology (BTO) and various authorities and counterparts in other Channel Islands.

Since its inception in 2011 BOTE has launched, promoted and undertaken local projects in a variety of fields of nature conservation and management, such as habitat surveys, grassland restoration, bracken management, conservation grazing, long-term bird monitoring schemes, farmland bird monitoring and conservation, hedge restoration, winter bird crop management, species re-introduction, and several awareness campaigns and community-focused events[1,2,3]. Over the years the work of BOTE has been financially supported by a wide array of local and international funding bodies, government grants, charities, trusts, and private donations. In 2018 the Roy Overland Charitable Trust granted BOTE with funding which allowed the Project Officer to undertake a three-year study and management trial based in the north coast of Jersey. The National Trust petitioned for this funding in view of the need to ascertain the ecological status and conservation needs of the Island's puffins, in order to safeguard their future and that of many other endangered seabirds. The work focused on gathering information on Jersey's puffin colony, as well as trialling ecological monitoring techniques and producing a long-term management plan for the species and its habitat.

1.3 The Plémont Seabird Reserve project

The work carried out by the BOTE project officer has revealed the unequivocal declines suffered by puffins and other seabirds in Jersey over the last century, in particular the two other species of auks which used to breed alongside puffins (Image 1). The project has also evaluated the habitat of many of the coastal areas where the present colonies survive, and quantified the presence, abundance and distribution of all known invasive terrestrial predators which can potentially threaten seabirds and other native wildlife (chapters 4 and 5).

Image 1. Population trends of auks in Jersey (1911 to 2020).



It is believed that the present location of the remaining puffin nests, which is mostly on the cliff-faces below the slopes, and amongst rocky boulders and crevices instead of burrows, reflects historical predation which would have happened at nests on the slopes. This is the natural puffin breeding habitat, however in Jersey these slopes are fully accessible to the terrestrial invasive predators found during the survey, with some of them encountered directly on the slopes. Therefore, it is likely that past predation pushed the puffins to nest in the cliff faces and that presence of predators on the slopes puts a swift end to any attempt from the puffins to re-colonise the slopes.

In view of this evidence, and of the importance, ecologically and culturally, of preserving the only remaining colony of puffins in Jersey, BOTE proposes the establishment of a reserve which will safeguard the species, its habitat and its other native inhabitants for the long term.

The reserve aims to encompass the puffin colony and its former breeding grounds, covering portions of land and sea. The land portion will be made safe and suitable with the installation of a predator-exclusion fence, the removal of the invasive predators and the management of bracken manually and by a grazing flock. The seabird breeding opportunities in the reserve can be enhanced with the installation of nest boxes or artificial burrows for puffins and other burrowing seabirds, and made more attractive to colonial breeders with the display of decoys or by playing audio recordings from other colonies. By sea, the protection of the colonies will involve awareness and education campaigns to reduce disturbance caused by human activities, and a biosecurity protocol to prevent re-invasion of predators. The present feasibility study report relates to the management of the invasive predators in the reserve; therefore, it covers the installation of the fence and the eradication of predators from within.

Works related to the reserve have already started on some fronts, such as raising awareness with education materials, boards, during public various events, and via de media. Habitat management is ongoing at the Plémont headland as well as the National Trust for Jersey land, and puffin nest boxes have been installed and provided with monitoring and biosecurity measures in two areas near existing nesting sites[4].

1.4 Predator-exclusion fence and eradication

Introduced species have had, and still are having, devastating impacts around the world. These impacts are magnified on islands, where species have evolved and adapted to live without land-based predators such as mammals. These introductions have caused the decline and even extinction of many species through competition of resources, direct predation and changes in their habitats[5,6,7,8,9].

There exists a vast and detailed body of work that covers eradications of invasive mammals such as rats from islands, in particular from New Zealand where such techniques were trialled and perfected. These techniques have become increasingly complex and ambitious, and therefore expensive. The price tag and the possible impact on local communities means that conservation managers need to justify the benefits of such projects and provide scientific evidence that warrants such extreme measures. However, when applied correctly, the results can be extremely beneficial, as proven by for most of the eradications that have been successful to date.

When a landscape or area is too large, or too complex to attempt a full eradication, such as the case of Jersey itself, the best alternative is the use of a predator-exclusion fence. Predator-proof fencing is a proven technology developed in New Zealand, with more than 50 fences been constructed to the date. These fences are capable of excluding animals as small as a baby mouse and are designed to prevent animals from digging under or climbing over the fence.

By protecting an area of land, the fence is effectively creating a ‘mainland island’ or even a ‘coastland island’ when it is by the sea. There are nowadays a number of ‘mainland islands’ around the world, from Australia and New Zealand where the technique was first developed, to Hawaii or the Azores, their design varying in accordance to the target invasive species, the characteristics of the site, the native species to be protected and social factors such as the involvement of the community and the public access strategy.

Once the fence has been installed, techniques developed for offshore islands to remove invasive predators and to prevent re-invasions can be applied and adapted to the fenced reserve with expected positive results.

1.5 The Feasibility criteria

The Pacific Invasives Initiative[10] is an international organisation compiling and providing technical expertise for conservation specialised in islands, including seabird conservation, invasive eradications and habitat restoration. Its guidelines propose that for an eradication project to be successful it must fulfil the following seven criteria:

- **Technically feasible:** Can the technique(s) be used at the project site to remove all individuals of the target populations?
- **Sustainable:** Can we prevent re-invasion of the target species?
- **Socially acceptable:** Does the project have full support from the community and other key stakeholders?
- **Politically and legally acceptable:** Will we be able to secure all required permits and consents?
- **Environmentally acceptable:** Can we ensure a manageable impact to the environment?
- **Capacity:** Do we have, or can we acquire all the required skilled people, resources and equipment?
- **Affordability:** Will we be to secure the required funding?

1.6 Terminology

Native: The International Union for the Conservation of Nature (IUCN) defines ‘native’ or ‘indigenous’ as species or race that occurs naturally in an area[11] (for this review, Jersey), i.e. whose dispersal has occurred independently of deliberate human translocation.

Non-native: The Joint Nature Conservation Council (JNCC) defines ‘non-native’, ‘non-indigenous’, ‘alien’ or ‘exotic’ as a species or race that does not occur naturally in an area, i.e. it has not previously occurred there, or its dispersal into the area has been mediated by humans[12].

Introduction: The deliberate or accidental release by human agency of an organism(s) into the wild by humans in areas where the species or race is not native[12].

Feral: An animal (or its descendants) that has been kept in domestication but which, following escape or release, now lives in the wild state.

Naturalised: A non-native species or race that, following escape or release, has become established in the wild in self-maintaining populations.

Invasive non-native species: A species which has been introduced into areas outside its natural range through human actions and is posing a threat to native wildlife.

Target species of this project: All the invasive non-native terrestrial predators found within the reserve area, which the project aims to remove and exclude from the reserve. Namely the brown rat, feral ferret, European hedgehog and cat.

Eradication: The complete removal of a species from a location into which there is little chance of reinvasion by natural dispersal.

Control: A reduction of the population size of a species, by sustained and constant effort.

Reserve area / site: In this report, the portion of land and sea designated as the Plémont Seabird Reserve. On land, it refers to the area protected by the predator-exclusion fence (Image 3).

Study area: The area comprising the reserve area and surrounding grounds where the different ecological surveys were carried out. The study area did not have exact boundaries as some of the research involved observing and recording animals far from where the observer was standing, or radio-tracking animals to wherever they had travelled. Most of the research was carried out within 50-200m from the boundary of the proposed reserve; however, on certain instances it extended several kilometers from it (Image 3).

Image 2. Channel Islands and offshore islets.

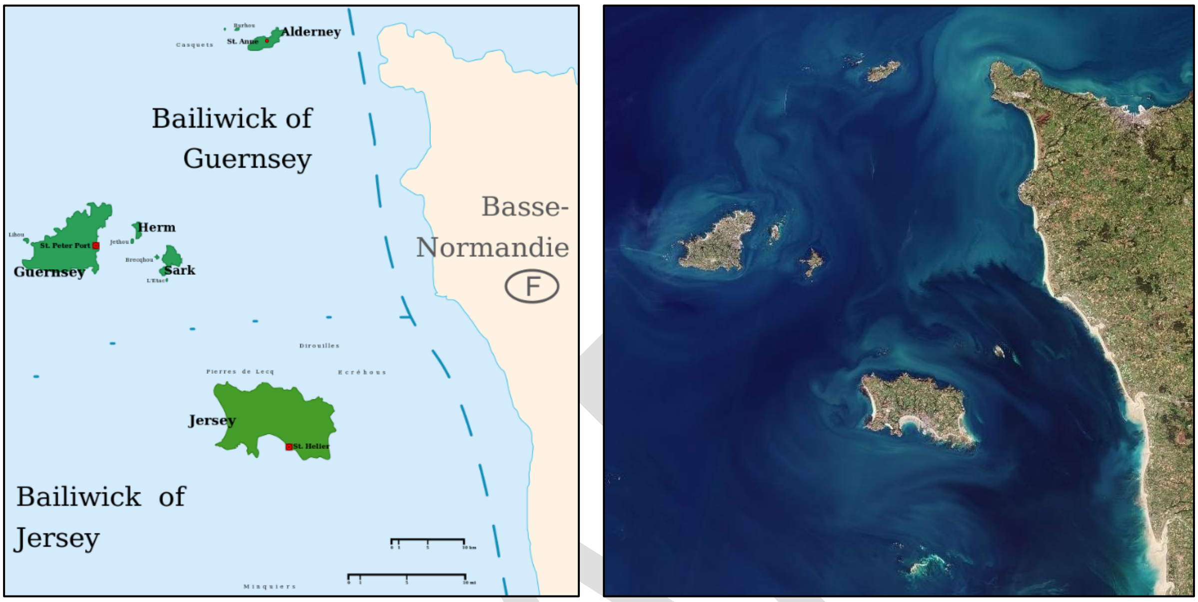


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Image 3. Location of study area in Jersey.

2. GOAL, OBJECTIVES AND OUTCOMES

2.1 Goal

The goal of the proposed project is to install a fence around the Plémont Seabird Reserve and to remove all known invasive mammalian predators from within, in order to create a safe and suitable breeding habitat for Jersey's puffins and any other native species in the reserve.

2.2 Objectives and outcomes

The objectives that the project will achieve and the outcomes that will be produced as a result of achieving the objectives are:

Table 1. Objectives and outcomes.

OBJECTIVES	OUTCOMES
1. Build fence	1.1 Planning documents and permission secured.
	1.2 Invasive mammalian predators are now isolated.
	1.3 Puffins and other seabirds are protected from re-invasions.
	1.4 Wildlife is protected from unmanaged human disturbance.
2. Remove invasive predators	2.1 New conditions support increase of puffin colony and expansion of breeding grounds.
	2.2 Re-establishment or colonization of new members of the seabird community such as storm petrels and Manx shearwaters.
	2.3 Increase in population of a range of terrestrial passerine species and other predation-vulnerable terrestrial and waterfowl species, breeding and migrant.
	2.4 A re-balancing of natural predator-prey relationships and a bottom-up trophic effect within the reserve occurs.
	2.5 Increase in population of terrestrial reptiles, amphibians, mammals and invertebrates and overall increase in biodiversity and species richness.
	2.6 Production of mitigation plans for non-target native species partially isolated within fenced area.
	2.7 Biosecurity measures are functional and effective.
	2.8 Re-invasion detection measures continue in perpetuity and response measures are in place to direct the management of re-invasions.
2. Restore seabirds' breeding habitat	3.1 Invasive bracken and other dominant plant species are removed or reduced.
	3.2 Conservation grazing flock is introduced.
	3.3 Plant community diversity increases.

4. Develop a participatory decision-making process	4.1 Partners have a regular forum in which to share information, collaborate on planning, and coordinate future project components.
	4.2 Fence installation and invasive predator eradication are developed and implemented with the community's awareness and support.
	4.3 The Island's community supports ongoing biosecurity and response measures.
5. Community engagement	5.1 Seasonal awareness campaigns are conducted and education materials are produced and made available to all Islanders.
	5.2 The community has an ongoing role in the decision-making process and management of the reserve.
	5.3 Participatory activities and events are organised to reach and engage a wide variety of demographic sectors of the community.
	5.4 Internship and research opportunities for local students emerge.
6. Improve quality of life and livelihoods on Jersey	6.1 Increased access to natural habitats and wildlife and encouragement of outdoor activities.
	6.2 Increased regulation and facilitation of commercial leisure activities and work in coordination with local operators.
	6.3 Hospitality businesses in the Seabird Reserve vicinity benefit from an increase of tourism and public visiting the area.
	6.4 Additional capacities are developed within the Channel Islands that relate to the planning and implementation of complex large-scale conservation projects.
7. Leverage each partners' existing capacities and build new ones in line with their missions	7.1 Each partner in the BOTE partnership has a role and contributes to the project's larger goals accordingly, leading to success of the overall project.
	7.2 Each partner develops additional capacities that facilitate implementation of their mission in the future.

3. STUDY AREA AND RESERVE SITE

3.1 General Description

Location

Jersey is the largest of the Channel Islands, with a total area of 118km^2 (45.6 square miles) and 70km of coastline (43 miles). It lies 30.5km from the Normandy Coast, France, and approximately 137km south of Great Britain. Jersey is inhabited and, with 107,800 people in 201913, densely populated. Jersey's coast is subject to the large tidal range of the Bay of St Malo, the 3rd largest in the world. Most seabird colonies in Jersey are found in coastal cliffs, which occupy the landscape of the north coast as well as the south-west portion of Jersey.

The study area is a two mile-stretch of coast in the north-west of Jersey, between the Plémont Headland and La Grève de Lecq Bay. The study area expands inland, into agricultural and urban areas depending on the research that was carried out. Some parts of the research took the project officer several kilometres from the edge of the proposed reserve, in particular when radio-tracking target invasive mammals.

The proposed site for the Plémont Seabird Reserve is the coastal strip of land between Plémont Bay and La Rocquerelle headland, coming inland to the cliffs below the public footpath. This is the only place in Jersey were puffins and razorbills breed. The proposed reserve would fall within the boundaries of the Jersey Coastal Park[14].

Image 4. Close-up of study area (blue square) and reserve site (white outline).

Habitat

The study area comprises steep cliffs with inlets, caves, rocky outcrops, headlands, promontories, and wooded valleys descending onto the sea from the interior land and farmland.

A 2020 ‘character assessment’ of Jersey’s landscape and seascape commissioned by the Government of Jersey placed the study area within the Grève de Lecq “coastal until”, which featured the following principal Character Types[15]:

- Cliffs and headlands
- Interior agricultural plateau
- Rocky shores and bays
- Offshore reefs and islands
- Shallow sea
- Deep sea

The cliffs from Petit Plémont eastwards (Image 5) are like most of Jersey’s north coast: slopes covered in dense and tall bracken - and as such, with little other species associated. Amongst the bracken there are occasional patches of gorse, bramble, and blackthorn, especially where the soil is shallower and around rocky outcrops. Along the coast, the bracken reaches almost all the way down to the cliffs, occasionally transitioning to an edge of coastal grassland where exposed rock and rocky outcrops start to appear. Closer to the top of the cliffs and near the footpath clumps of Holm oak and other trees can be found.

Image 5. Coastal cliffs between Petit Plémont and the Grand Becquet headland.

The terrain and habitats of the Plémont headland (Image 6) are distinctively different from the coastal cliffs. The bracken is much less vigorous and mixed with a larger number of species, and there are distinctive areas of different plant communities. These include short coastal grassland, gorse patches, open swards of short grasses and little tussocks, rocky ground with various lichens, as well as bracken-dominated areas, sometimes co-associated with bramble and other species[16]. The striking difference in landscape, character and communities of the Plémont headland, compared to the rest of the study area, is possibly caused by its topography, exposed location, areas of shallow soil and the grazing effect of rabbits, which are abundant in the headland.

Image 6. Plémont headland.

Land use and human activities

The agricultural fields above the cliffs are mainly used for growing seasonal commercial crops, silage crops or for grazing. The footpath (Image 7) is used by walkers and sight-seers, as well as by educational organisations and charities, professional dog-walkers and tour operators, with a focus on the landscape and the wildlife of the area. There is a small area below Petit Plémont where people sometimes swim, and four main sites where hobbyist anglers fish from. There is a clay target shooting range on a small headland, near the eastern end of the reserve.

Image 7. Public footpath between Plémont and Grève de Lecq.

The waters around the reserve are commercially fished with lobster and crab pots, as well as line-fishing from the boats when the conditions are suitable. This small fishing fleet is mainly based at Grève de Lecq bay. Recreational activities such as coasteering and trips on paddle board, kayak and boat also happen in the area, both commercially and privately. However, there is a voluntary code of conduct known as the Seabird Protection Zone[17] (SPZ hereafter), which encourages people to avoid visiting the waters in the area during the seabird breeding season altogether, in order to avoid causing damage or disturbance to wildlife (Image 8).

Image 8. Seabird Protection Zone.

Although no surveys were undertaken with the sole aim to record human presence and activity in the study area, ad-hoc observations were recorded during the other surveys, especially of any activity in the Seabird Protection Zone. This research found that most tour operators avoided commercial activities within the SPZ during the breeding season, and that the commercial fishermen avoided unnecessary disturbance by limiting their time spent in the SPZ to the minimum necessary. The general public, however, visited the SPZ with boats, kayaks and paddle boards in several occasions during the breeding season (Table 2). A survey conducted amongst recreational users at the launching point of Grève de Lecq revealed a lack of awareness of the SPZ amongst the majority. A small minority of people revealed their knowledge of the SPZ, but expressed lack of concern based on the belief that their behaviour did not have a negative impact on the seabirds breeding in the SPZ.

Table 2. Leisure craft observed in the SPZ between March and July.

	2018	**2019**	**2020**
N craft	12	41	46
during watches	*10*	*7*	*13*
N watch hours	103.5	145.5	61.0

Despite not having a large sample size, with only three years of watches in the study area, an interesting difference was noted between the years 2019 and 2020, with the latter year seeing an increase of 360% in the number of leisure craft observed per hour in the SPZ during the breeding season (Images 9 and 10). It is not possible to ascertain the exact reasons for this increase without a survey amongst the craft users, however it is believed that it could be the result of the restrictions on other activities which were present at the time as part of the Government of Jersey Covid-19 pandemic strategy.

Image 9. A group on closed-top kayaks following the edge of the Plémont headland.

Image 10. Two different groups on open-top kayaks exploring the caves below puffin and razorbill nests.

Public access

There is a public footpath between Plémont and the shooting range. The walking route eastward then veers inland via small lanes and between buildings, until it becomes a footpath again overlooking Grève de Lecq Bay. The path descends on the west side of the bay and ends behind the Prince of Wales establishment. The Plémont headland itself has no public footpath, but people access it by foot via a steep slope (Image 11).

Image 11. Public footpath (green), proposed fence location (white), inhabited buildings (red), and historical buildings numbered according to Table 3.

Buildings

There exists a large number and variety of human-built structures in Jersey that reflect the activities and settlements across the ages. The first known human presence in Jersey dates back from 250,000 years ago, when nomadic groups used natural caves in the south-west for hunting activities. The first structures were built by settled communities during the Neolithic period, and comprised a variety of burial sites such as dolmens and passage graves across the Island.

There are three Neolithic sites in the vicinity of the study site[18] (Table 3). Within the proposed reserve there are components of the Stroingpoint Plémont, a multi-leveled defence complex built during the Occupation (Image 11).

Table 3. Historical buildings in or in the vicinity of the reserve.

<table>
<tr><td>1. La Hougue Des Géonnais</td><td></td></tr>
<tr><td colspan="2">A Neolithic passage grave built around 6,000 years ago. Comprises a passage leading into a large open rectangular chamber. This monument had been damaged during excavations. Stones taken by quarrymen were replaced later with granite blocks to show their original position. Finds at the site also include flint tools, decorated pottery fragments and broken querns[22].</td></tr>
<tr><td>2. La Hougue Le Bêqui</td><td></td></tr>
<tr><td colspan="2">A large megalithic structure below a mound, found on private land and first mentioned in 1817. Type of site and date are presently unknown. Findings consisted of a capstone, twelve slabs, pottery and cremated bones[20].</td></tr>
<tr><td>3. La Rue de la Croute Tummulus Site</td><td></td></tr>
<tr><td colspan="2">Classified as an area of archaeological potential, it is believed to contain a mound of earth or stones raised over a grave, also known as a tumulus[21].</td></tr>
</table>

<table>
<tr><td>4. Plémont Fort & Guardhouse</td><td></td></tr>
<tr><td colspan="2">Believed to have been originally an Iron Age fort, the British built a guardhouse at this site in the 18th Century. The structure was substantially altered during the Occupation, turning it into a "reinforced field position", with an emplacement with twin machine guns, a mortar emplacement, an observation post, and a searchlight shelter with railroad tracks that could move the searchlight to twin operating sites.</td></tr>
<tr><td>5. Plémont Guardhouse Tower</td><td></td></tr>
<tr><td colspan="2">This small tower, part of the original Guardhouse construction, was modified by the Germans during the Occupation and fitted with an anti-aircraft machine gun.</td></tr>
<tr><td>6. Machine Gun Emplacement and Shelter</td><td></td></tr>
<tr><td colspan="2">This small bunker was built during the Occupation and is situated on the cliffs below the main M3 observation bunker.</td></tr>
</table>

7. M3 Army Observation Bunker	
This large building dominates the complex from the high ground. It was designed to watch the coast and provide coordinates to the Artillery Batteries across the island.	

The buildings in present use which are closest to the study area are private houses, farm buildings and sheds, and a café. The inhabited building closest to the reserve is at 329m distance of its edge.

Weather

The prevailing westerly winds are often felt in the study area, especially in the headlands. The annual average wind speed is 15.2mph (data from Jersey Airport and Weatherspark statistics, 1980-2016). The Island can occasionally experience violent storms (64-72mph, Beaufort scale) which can be accompanied by gusts of hurricane-strength winds (73mph and over). The average rainfall in Jersey is 875mm/year (Jersey Met Climate Statistics, 1981-2010), with the wetter season being from September to March.

3.2 Land ownership and management

The portion of land comprising the Plémont headland and the cliffs below the public footpath, up to the eastern edge of Creux Gabourel headland, is owned by the Government of Jersey and is managed by the Natural Environment Department. The Department manages the land to promote biodiversity and to prevent encroaching of dominant vegetation such as bracken, gorse and bramble. These species are cut seasonally in certain areas, in order to open up ground and to help establish coastal grasses and native flowering plants (Image 13). A smaller portion of coast, found between the shooting range and Grève de Lecq, is also publicly owned. The land below the public footpath between Creux Gabourel and the shooting range is the Common du Fief de Vinchelez, and is privately owned (Image 12).

Image 12. Ownership of the land within the proposed reserve boundaries and fence (white line).

Image 13. Coastal cliffs east of Plémont headland managed by the Natural Environment Department.

The fields and land parcels above the footpath belong to various landowners. Amongst them is the National Trust for Jersey, which owns the land above the Plémont headland and adjacent fields, as well as a portion of coast between the shooting range and Grève de Lecq Bay. The Trust removed the derelict holiday camp buildings from this land and now manages it to increase biodiversity and restore coastal habitats. The agricultural fields owned by the Trust are leased to cattle or sheep farmers for grazing (Images 15 and 16).

Image 14. National Trust land at Plémont after ground restoration works.

Image 15. Restored wildlife pond within the National Trust land at Plémont.

4. SITE ECOLOGY AND CONSERVATION VALUE

4.1 Methodology

From 2018 until December 2020 a variety of ecological surveys were conducted in the study area as well as desktop reviews. The main aim of this research was to establish the historical decline and status of the puffin population and its present threats, but it also included other native species and threatened wildlife, as well as the presence and activities of people in the study area.

Some methods were species-specific, such as the puffin watches, whilst other methods collected data more broadly, such as motion-triggered cameras or baited live traps. Most of the research was carried out in the study area, and where possible the results distinguished between data originating from within the proposed boundaries of the reserve and data from outside of the reserve.

Desk Review

All available records of puffins, razorbills, guillemots, fulmars, storm petrels and Manx shearwaters in Jersey were compiled and analysed. Most of the records were obtained from the Société Jersiaise Ornithology Section, by examining more than 30 folders, scrapbooks and hand-written notes where the records are physically stored. Other sources were the reports from local seabird census, as well as individual reports of sightings from social media. Information from other Channel Islands was also collected when available.

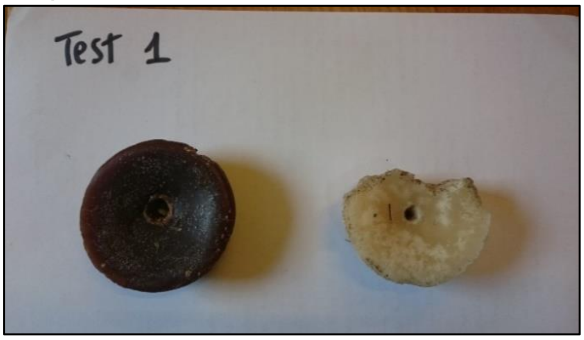
Bait and footprint tunnel trials

During the months of October, November and December 2018 trials were undertaken to determine the validity of different monitoring techniques used in similar projects such as in the Isles of Scilly and Lundy Island. These techniques have been designed to detect the presence and distribution of rodents and other small mammals, and as such can be applied to study invasive predators. The techniques that were trialled were motion-triggered cameras, flavoured wax blocks, and footprint tunnels. Most of the techniques were monitored by motion-triggered cameras as a means to test their effectiveness and uptake by mammals in the area.

Flavoured wax blocks were used with the aim to study the bite markings on the block and to identify the species based on the tooth indentations. Other baits such as peanut butter and sardines were also used to test the reliability of the cameras. The footprint tunnels consisted of a long and narrow piece of white card which had inked edges and bait placed in the middle of it. The card was fitted inside a small black plastic tunnel. It was hoped that this technique would provide feet imprints of small mammals, as they would step onto the inked areas and leave footprints on the white carboard when walking towards the bait. Typically, species can be identified from clear prints of feet, based on the shape and size of the foot as well as the stride distance.

During the trials these two techniques did not appeared useful for their purpose, mainly due to the presence of non-target species which interfered with the results. As the cameras showed, the wax blocks were chewed by many species, such as field mouse, brown rat and bank vole, leaving the blocks so damaged that it was difficult to ascertain if the target species, mainly the brown rat, had been involved (Images 16 and 17). Similarly, the cardboards used on the footprint tunnels were heavily marked with footprints of many species and this made the identification of the target species very difficult. In the worst cases, the carboards themselves were found chewed to small bits (Images 18 and 19).

Images 16 and 17. Favoured wax blocks before and after bait tests.



Images 18 and 19. Footprint inked card with bait before and after test in tunnel TT4.

Puffin Watches

Watches were carried out at the puffin breeding sites each year between February and July of each year in order to determine presence, numbers, activity and breeding success. During the watches the same data was collected for razorbills, as many razorbill pairs could be monitored from the same watchpoints. Early on, watches required intensive working days with long hours, but each subsequent season the methodology was streamlined. By 2020 the information collected was reduced to census and productivity and the watches evolved into a locally-devised seabird monitoring strategy for population and productivity, which also covered all other seabirds breeding in the study area (see next).

Seabird population and productivity monitoring

In 2020 all seabirds breeding in the study area, including puffins, were monitored following a methodology adapted from the Seabird Monitoring Handbook of Britain and Ireland (1995 JNCC)[22]. The purpose of this survey was to collect the required information regarding the present puffin population but also to establish a baseline of data on population size and breeding productivity for all seabirds at the study area. This data then could be compared against previous seabird census carried out island-wide, as well as used to monitor the effect of future habitat and wildlife management works.

This survey consists on mapping each potential seabird nest via photographs, and checking each at specific times of its life cycle in order to determine breeding status and success. The method can be applied to most diurnal seabirds but the timing varies depending on the species. This particular method was designed to monitor small colonies which cannot be accessed by land, therefore it was found to be the most suitable for the study area.

Coordinated census

In order to ascertain the size of the puffin population during the breeding season, between one and three coordinated counts were carried out each year across the study area, by a team of volunteers watching from different vantage points. The aim of these counts was to record all puffins observed at sea or on land, and to cover as many blind spots as possible in order to ensure that all the breeding population was accounted for. Razorbill numbers and guillemots, if present, were also recorded during these counts.

Playback survey

The method of recorded playback surveys is designed to detect burrowing nocturnal birds, such as storm petrels or Manx shearwaters, by enticing a vocal reply when their natural call is played on a device near, or at the entrance of, their burrow. This method is best conducted during the day, whilst the animals are inactive, and allows to detect burrow occupancy with minimal disturbance. However, not all animals reply and there is a known response rate for each species which needs to be applied to the results obtained[23].

A playback survey was carried during the 2018 breeding season across the Plémont headland (Image 20), as it was all the land in the study area which could be found to contain visible burrows and which was accessible by foot. The headland was divided into working sections and recordings of both storm petrels and Manx shearwaters were played for a few minutes each, at every entrance of burrow or hole in the ground.

Image 20. Area covered on the playback survey.

Bird Ringing

Scientific bird ringing has been carried out at the Plémont headland since 1999. Between one and three night-time ringing sessions, usually carried out in July, aim at trapping and ringing nocturnal seabirds such as storm petrels and Manx shearwaters. Health, breeding condition and various biometric data is collected as well, and all records are entered in the database of the Channel Islands Ringing Scheme. Any birds that already have a ring when caught have their ring code submitted via the official channels in order to receive the information from their original ringing (such as location, date, age etc).

Automated Acoustic Recording

Acoustic recorders are increasingly being used as a way to monitoring the presence of species which use calls or other acoustic means to communicate and navigate, like bats or nocturnal seabirds[27]. The recorders are set up in chosen locations and programmed to record at a set frequency and time, or time intervals, for days, weeks or whole seasons.

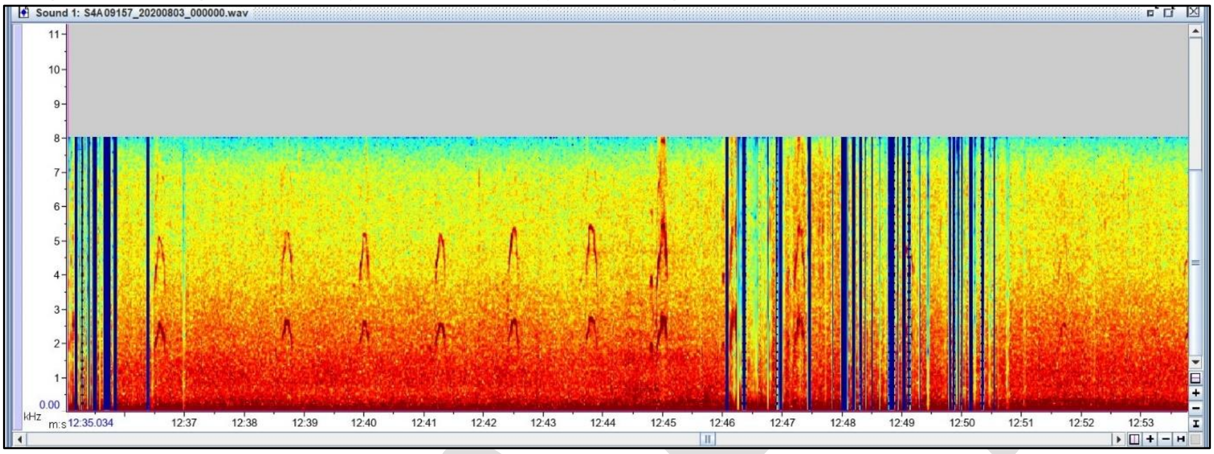
An acoustic recorder was borrowed from the Agile Frog Project of Natural Environment Dep. and set up at the Plémont headland, in an area where Manx shearwaters are heard (Images 21 and 22). The recorder was set at the frequency most used to detect shearwaters and petrels, and programmed to record for a period of 20 minutes every hour between 10pm and 5am for the month of August 2020.

Image 21. Set up of the acoustic recorder.

Image 22. Location of the acoustic recorder facing east from the Plémont headland.

The recordings analysed to date did not contain any sounds of Manx shearwater of storm petrel, but did capture the calls of various gulls and oystercatchers, which were easily identifiable (Image 23). The lack of recordings from the species of interest might be due to a wrong positioning of the equipment, or most likely might reflect a real absence of the species in the area, which is expected at this time of the year. Due to logistic constraints, the equipment could not be borrowed until August, which is considered late in the breeding season, and the presence of visiting or prospecting birds is probably significantly reduced.

Image 23. Audiogram of an oystercatcher's repeated single note call obtained from the recorder.



As the recorder succeeded in capturing and recoding the sounds of other seabird species, there is no reason to believe that it would not capture the nocturnal seabirds if they were in the area. This technique has proven to be a cost-effective method to monitor changes in populations of seabirds in the long-term[28], and therefore it is suggested that a similar method is implemented in 2021 earlier in the season, and tested during nights in which shearwaters can be heard directly by researchers, in order to corroborate the location and set up that is most effective for the recorder.

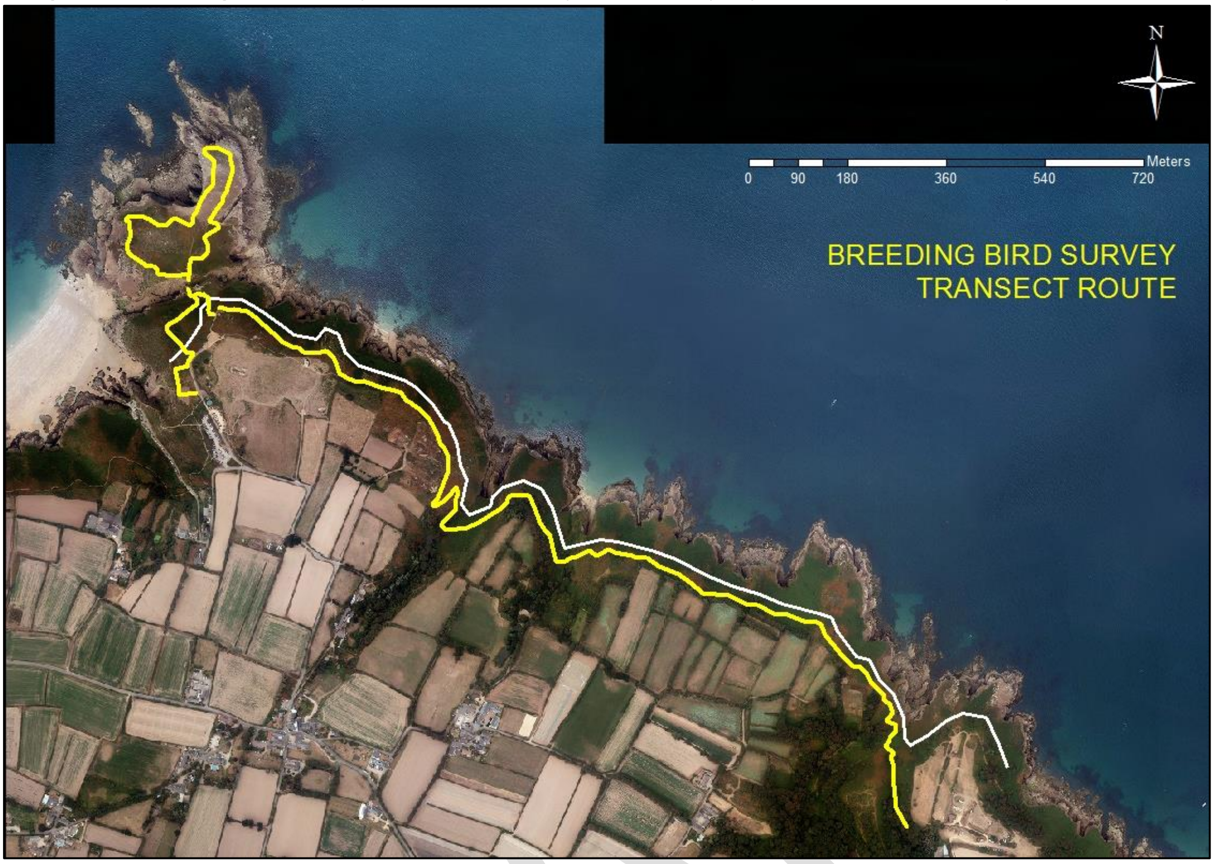
Breeding bird survey

This method was adapted form the British Trust for Ornithology's Breeding Bird Survey, which is a long-term nation-wide survey undertaken by volunteers, each at a random quadrant of the territory which gets checked twice per year, each year[26]. The two checks correspond to the early and late stages of the breeding season. The survey provides data which allows for monitoring land bird species and their populations, showing trends over long periods of time.

The surveys consist broadly of walking a set route or transect and to record data on all birds observed during the walk: species, sex, activity, and location in reference to the transect. The survey is carried out twice during the breeding season.

A Breeding Bird Survey was devised and trialled in 2020 in order to detect land birds present at the study area and to monitor changes in their populations over time, especially in relation to potential management of habitats and invasive predators. A transect route with a length of 3292m was chosen to be surveyed, and was later broken down in three sections of 825, 382 and 2084m (Image 24). The 'early' survey was carried out in May and the 'late' survey was carried out in June, with all observation and environmental data entered on survey forms and maps.

Image 24. Breeding bird survey transect route (yellow) and proposed fence boundary (white).



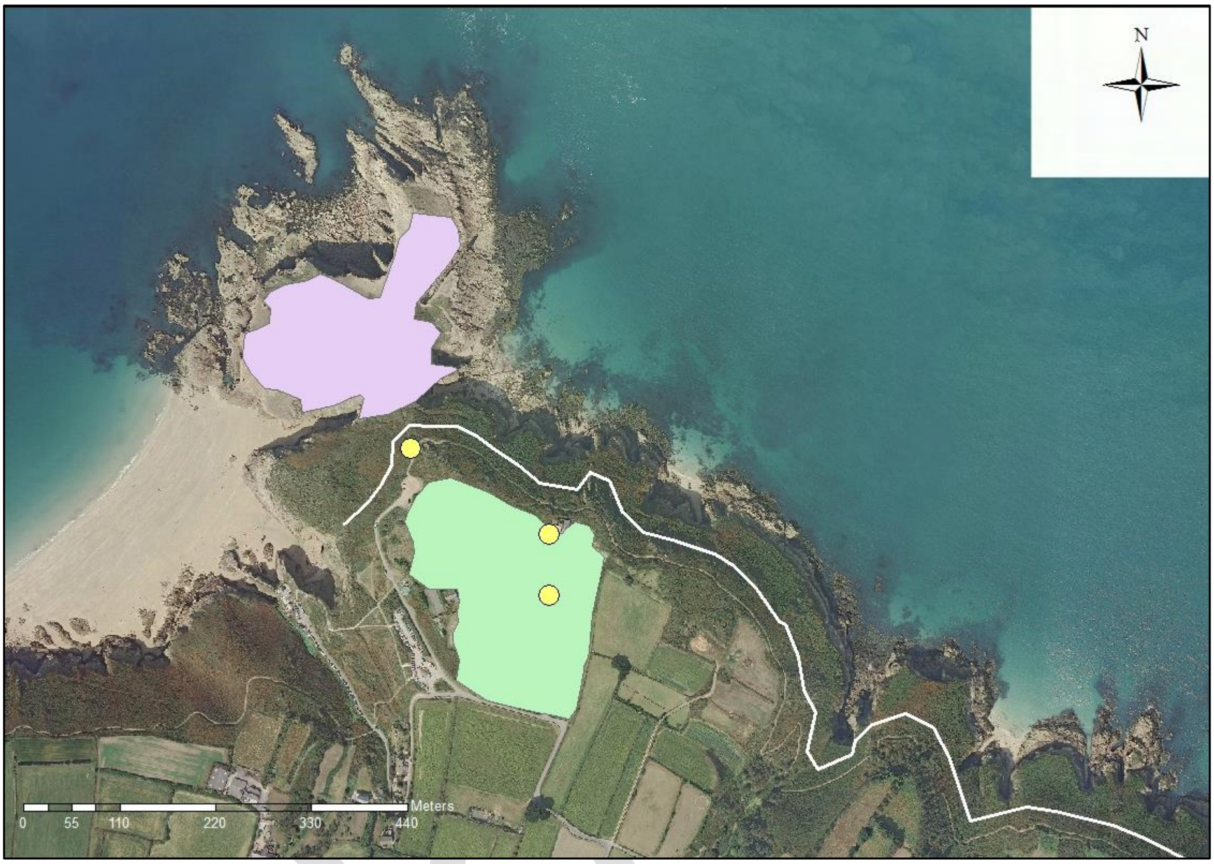
Dusk Surveys with Thermal Imager

The use of thermal imagers is becoming widespread in the field of wildlife research, as they become smaller in size and price. The most accessible format comes in the shape of a hand-held scope which is used to look for animals at night, although it can also detect an animal's heat during the day. Thermal scopes are very useful to find and record animals which cannot be easily detected with the naked eye, such as nocturnal animals or diurnal animals which are very well camouflaged.

A thermal imager was purchased for the project and was used to trial a monitoring programme for rabbits in 2020. Rabbits are seen on most of open ground in the survey area, and are the most likely main prey to feral ferrets, therefore monitoring their population in the long term would provide an insight into ecological changes in the community after the invasive predator eradication. As they are mostly nocturnal, various survey techniques were considered and it was decided that the use of a thermal imager would be the one less likely to cause disturbance in the study area.

Following guidelines from long-term rabbit monitoring programmes[27,28] trial dusk surveys started in June and were carried out each month, except in August, on three consecutive nights of similar weather; or three nights in a period of four consecutive nights, if a change in weather had disrupted the three-night strike. The first few surveys were carried out at sunset. In November they were also repeated one hour after sunset, and finding this time more suitable for logistical reasons, from December onwards they were carried out one hour after sunset. The dates for the surveys were chosen based on favourable weather conditions, avoiding nights with rain or high humidity. The survey recorded all rabbits and unknown mammals observed in the Plémont headland and the NTJ land above the headland (including the open grassland and adjacent fields). The observations were made from three vantage points visited in the same sequence each time and consisted of three consecutive visual sweeps of each area, with the highest count of the three being recorded (Image 25). Of the three counts carried out each month, the maximum per area was used for analysis.

Image 25. Vantage points (yellow dots) and areas covered by the dusk survey.



Motion-activated Cameras

Six automated motion-activated cameras were used initially in 2018 to monitor the testing of other techniques such as trapping and flavoured baits, but from November 2018 and up until early 2020 four of them were permanently set up to monitor invasive predators across the study area. The cameras were usually programmed to take three pictures and a 20-40 second video at each trigger, and the resting period between triggers was between 10 and 30 minutes, adjusted depending on the wind, which appeared to trigger some cameras when it was very strong.

The cameras collected images of any wildlife which appeared on their field of vision, from mammals of all sizes, birds, reptiles and amphibians, to even small invertebrates such as slugs, centipedes, and moths.

The four cameras which were mainly dedicated for monitoring all year round worked for an average of 100 days per year and produced 24,237 image files, of which 19,804 were photographs and 4,433 were videos. The videos amounted a total of 34 hours of footage. The cameras were triggered 6,805 times, but only 1,427 of them featured one or more vertebrate animals. Whilst this would not be considered a reliable tool to study the population size or movements of invasive predators, it is considered useful for detection and distribution purposes.

Live trapping and mark/recapture

In 2017 a visiting specialist carried out a 7-day trapping survey in the study area, during which local staff including the BOTE project officer were trained on the basics of live-traps as a means of monitoring invasive predators[29]. In May 2018 a trapping programme was trialled with a total of 34 traps set in the study area, and as it produced positive results it was carried on until end of 2020. The traps were suitable for safely catching animals of a size between a small rat and a medium-sized cat, with a mesh size that would allow non-target species and small mammals to step through comfortably. The cages were labelled, and retro-fitted with dark plastic covers to prevent weather exposure. The staff was trained in wildlife handling and the required licence was secured from the Natural Environment Department.

Starting on May 2018 and throughout 2019, one trapping session of five consecutive nights was carried out each month. Bad weather, road access and seasonal changes in vegetation did not allow for all traps to be accessible or suitable for use at all times, so the number of traps being used at any time varied between 10 and 34. In 2020 the trapping effort was reduced by 50% and trapping sessions were carried out bi-monthly.

Every evening traps were baited and set, and each morning traps were checked and closed for the day. Any non-target species which was accidentally captured (only rabbits in this case) were released. Each target species (brown rat, feral ferret, European hedgehog and cat) had a different handling and processing protocol. Rats were photographed, weighed when possible, and released – it was not possible to mark them. Feral ferrets were measured and marked, and in some cases fitted with radio-tracking collars. Hedgehogs were measured, marked and released. Cats would have been taken to an appropriate charity, or marked and release depending on their status - but none was ever caught.

Radio-tracking

Some of the feral ferrets caught during trapping rounds were fitted with radio-collars which could be tracked with a receiver. Ferrets are most active during the night, resting during the day in an underground den or burrow. Radio tracking was carried out during the day, in order to locate the dens or burrows. In some cases, the signal was not strong enough, or hidden by the terrain, and the den could not be located. However, when the conditions were right the ferret was located within meters of error, or even as close as the entrance to the den where it was resting.

The location of the den or area where each ferret was located was marked on a map, notes were taken on tracks or signs in the vicinity, and dens were photographed for reference.

Refugia Monitoring

This type of monitoring scheme is targeted mainly at reptile species, although it can also detect amphibians and small mammals. It involves visual checks of special mats or ‘refugias’ laid out on the ground which different species are attracted to and use for hiding, resting or sunbathing. A refugia-based monitoring scheme has been successfully implemented across the Island as ‘Reptilewatch JE’ by the Jersey Amphibian and Reptile Group (JARG), which has been advising BOTE on this matter[30].

In preparation for the surveys, 20 refugia mats were laid out across the study area in the spring of 2020 (Image 27). Unfortunately, the subsequent checks could not be carried out due to restrictions related to the Covid-19 pandemic. It is believed that this monitoring scheme can produce data adequate for long-term monitoring of reptiles, amphibians and even small mammals, and it is hoped that surveys will start in 2021.

4.2 Results

4.2.1 Puffins and other seabirds: Past and present populations

Puffins

Image 26. Three puffins near the nesting sites in the study area.

© Romano da Costa

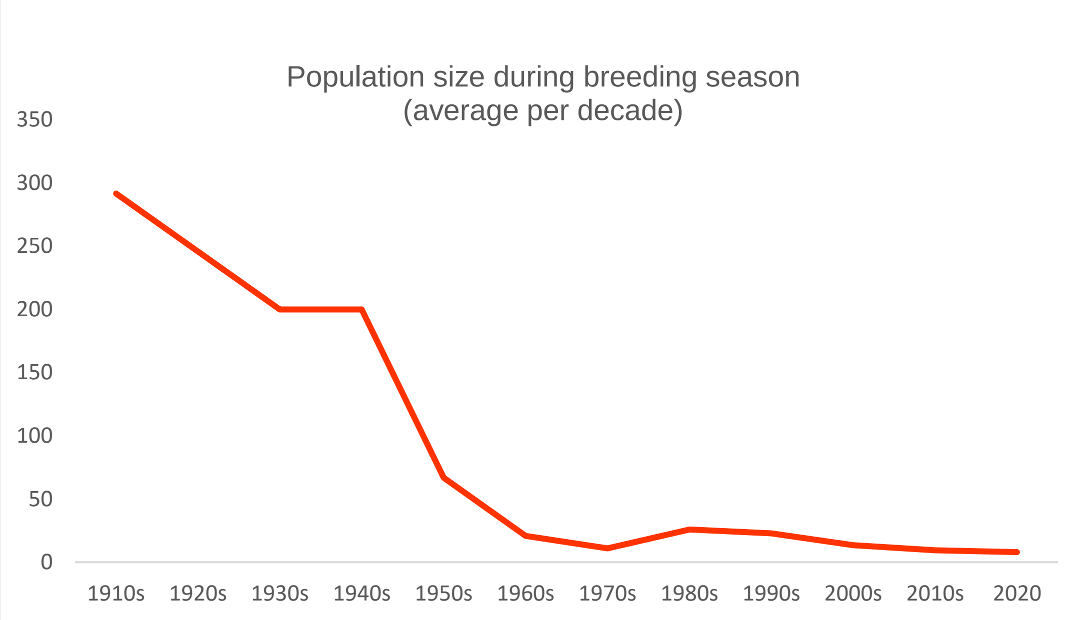
The puffin, a small seabird member of the auk family, spends most of its life at sea and only comes to land to breed. Puffins breed on coastal grass slopes facing the sea, where the pair digs a burrow, or uses a rabbit warren, to line it with grass and make an underground nest. Puffins mature at about five years of age, returning to the area where they were born to look for a mate and breed. They arrive to their breeding grounds in March to return to their nest. The female lays one single egg, and the chick or 'puffling' is raised inside the burrow. When the puffling is almost ready to fledge, it will come out of the burrow at night to observe the landscape and orientate itself. This is done to prepare for fledging, puffling will fly off to sea at night and alone, and will not see its parents again after that. Immature puffins take 5 years to reach breeding age, however they visit the colonies where they were raised before they are fully mature, particularly at the end of the breeding season (July), to prospect for breeding partners and nesting opportunities.

Puffins are rare breeders in most of the Channel Islands and are seen very rarely in the winter. Their local stronghold is Burhou, Alderney, which is monitored by the Alderney Wildlife Trust. According to the Trust's latest Ramsar report, the population estimate in Burhou for 2020 was 167 pairs. Although this population has fluctuated around the 200 mark since de year 2000, it suffered a dramatic decline in the 1970s and '80s, when it shrank from 1,028 individuals in 1970 to only 330 in the '90s.

The smaller colonies in Sark and Herm (Guernsey) have both fluctuated between 50 and 10 individuals since the 1970s, and birds seen on the water near the breeding sites suggest a small breeding population in each island, although there is no data available which would confirm numbers of occupied burrows[31].

The earliest records in Jersey date back from 1911, when 200 individuals were counted during breeding season. The population reached a peak in 1912-1914, with many dozens of pairs each year estimated to add up to around 500 individuals. The population decreased down to 80 pairs (160 birds) in 1950 and 1951, and from the late 1950s to the year 2000 the yearly average decreased from 50 to 10 birds. Over the last 20 years (2000-2020) the breeding population has fluctuated between 10 and 2 individuals, and it presently stands at 4 confirmed pairs in 2020 (Image 27).

Image 27. Population trend of the puffin in Jersey (1911-2020).



The Jersey puffins appear to have always been between Plémont headland and Grève de Lecq Bay. The only local records not within this area, taken during the breeding season, feature puffins which were travelling past Grosnez point. It is likely that puffins from other islands visit Jersey during their foraging trips and that puffins breeding in Jersey visit waters around other nearby colonies too. The diet of the Jersey puffins appears to be mainly of sand eel, as seen on high-resolution pictures volunteered by local photographers, and puffins and razorbills are often observed diving and fishing on the waters directly below their nesting cliffs.

The recent efforts to monitor the puffins breeding in Jersey, led by the National Trust for Jersey and the BOTE partnership, have produced a reliable account of the size, distribution and productivity of this very small population over the past four years (Table 4).

Table 4. Puffin nest summary 2017-2020 (green: nest visits; blue: food delivered).

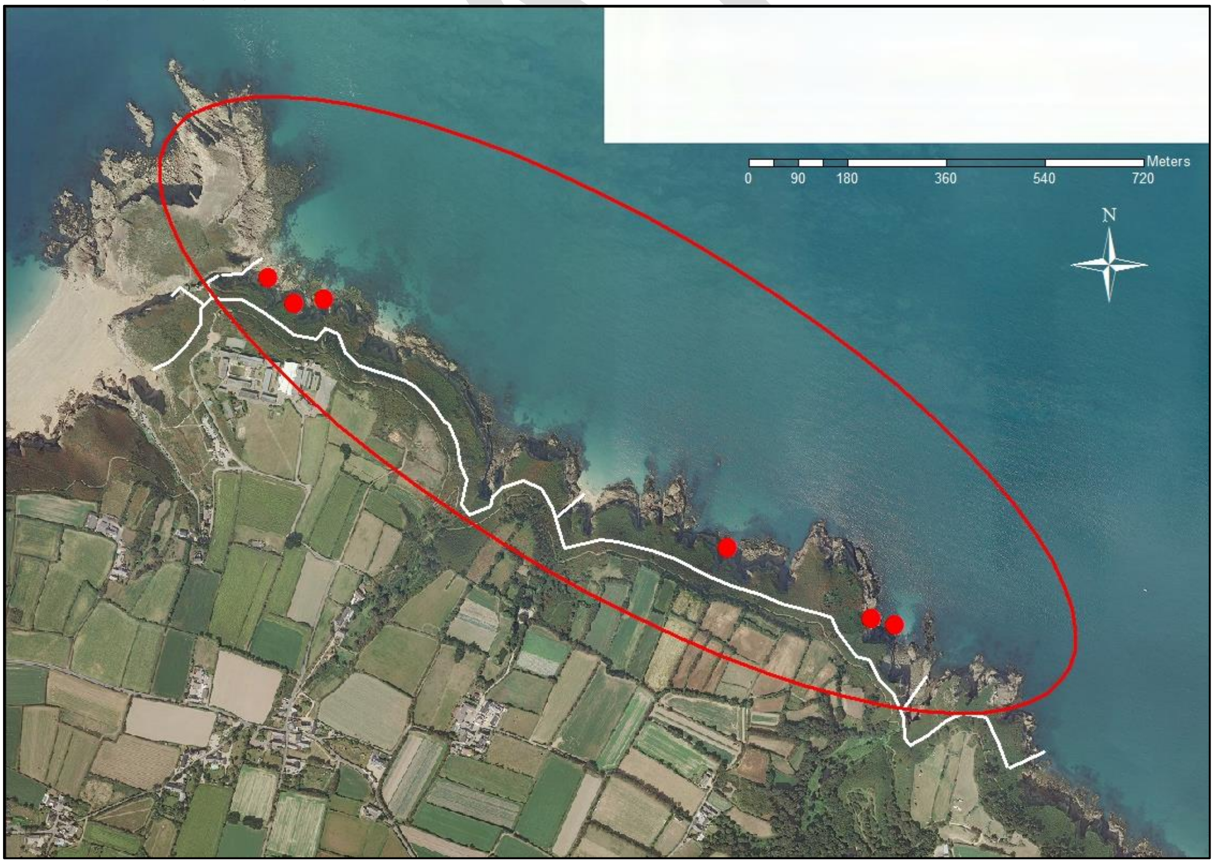
NEST	DESCRIPTION	2017	2018	2019	2020
1	On rock face, entrance below rocky overhang on ledge	✓	✓✓	✓	✓
2	On same rock face as 1, entrance at the end of the ledge behind large boulder	✓✓	✓✓	✓✓	✓✓
3	Burrow on ground amongst rocky outcrops, below vegetation line	✓✓	✓✓	✓✓	✓✓
4	Entrance out of sight, above large boulder below vegetation line		✓✓	✓✓	✓✓
5	Entrance out of sight, above grassy ledge facing east on rocky outcrop				✓
6	Entrance below rocky outcrop, at lower edge of vegetation line				✓✓

On 2017 three nests were located and one more was suspected but not located, with food being brought to at least two of them[32]. As food is only brought to the nest for the purpose of feeding the chick, it is accepted as a sign of the chick having hatched. On 2018 the three nests found in 2017 were active with the fourth nest located. Much time was devoted to watching the nests. Food deliveries were observed for all of them, confirming that four chicks had hatched in their respective nests. In what was a very rare occasion, the puffling of one of the nests was seen one morning stepping outside of the nest, standing for a few minutes at the entrance of the burrow, before going back inside. This was probably the first sighting of a puffling in Jersey on recorded history.

In 2019 the same four nests were active again, and a fifth nest was suspected, but not confirmed. Three out of the four nests had food delivered, confirming that there were at least three chicks being raised. The pair on the fourth nest were seen visiting the nest often all throughout the season, therefore it was highly probable that they that been successful too in raising a chick.

On 2020 the time dedicated to watches was reduced to less than half from 2019, mainly due to the Covid-19 pandemic restrictions. All the four known nests were active again, and two new nests were identified in the vicinity (Image 30). Of these two new nests, one had signs of a chick being reared, with multiple food deliveries by the adults, and the other nest had puffins present throughout the season. Three of the other four nests had fish brought in, with the remaining nest seeing continuous activity by the breeding pair, even though a food delivery was not observed.

Image 28. Location of puffin nests in 2020 (red dots), former breeding range (red outline) and boundary of the proposed fence (white line).



The lack of sightings of fish being taken to two of the six nests could be attributed to the significant decrease in time dedicated to watches, whereas the fact that puffins were seen at the nest throughout the breeding season probably indicates that they had a chick there too – especially in a nest which has had a breeding pair consistently for the last four years. The conclusion from the 2020 season was that there were six active puffin nests, of which four were very likely to have produced pufflings, and with the other two nests quite likely to have had pufflings too.

Image 29. A puffin on its way to take several fish to a nest in the study area.

© Wilson de la Haye

The puffin is probably the most endangered seabird in Jersey, and one of the most vulnerable animals in Jersey. The review of its status and realization of the precarious situation of its population, highly vulnerable to extinction, prompted the start of the Plémont Seabird Reserve Project. The puffin is not only this project's flagship species, thanks to its charisma and iconic presence in the cultural heritage of Jersey, but it also acts as an ecological 'umbrella' species, meaning that by protecting it and restoring its habitats, many other native species of birds, reptiles, mammals and invertebrates will also be protected as a result.

The precarity of the puffin population in Jersey cannot be understated, and to reflect this it has been placed in the Red List of Jersey Birds of Conservation Concern[33]. A population as small as four to six breeding pairs is highly vulnerable to extinction in a very short time – as short as a single year, if a particularly negative random event were to cause all individuals to perish, such as very bad storm or a disease, for example.

On a hopeful note, the fact that there appeared to be two new pairs in 2020, one of them successful on their attempt to breed, and the second one prospecting a nest at the very least, if not successful too, might be interpreted as an increase in the local population, either by recruits from other colonies, or by individuals born in Jersey reaching maturity and coming back to their natal cliffs to establish a nest. As social breeders, prospecting puffins are more attracted to sites which already have puffins breeding on, and the larger the existing colony, the bigger the attraction to new recruits. It is to be hoped that this small increase in numbers in 2020 might increase the interest to potential pairs which might have visited the area at the end of the breeding season.

All the existing nests are, however, in sub-optimal locations, namely on rocky slopes and cliffs, below the vegetation line. Some seem to be hollow spaces between rocks and ledges, and others appear to be excavated holes between large boulders and rocky outcrops. This distance from the slopes above, where puffins would usually make their burrows, might be due to the presence of invasive predators on these slopes, and to the widespread and dense bracken cover.

Image 30. A puffin stands outside its nest (bottom left quarter) below fulmar nests in a rocky vertical cliff in the study area.

This study concluded that if the coastal slopes above the sea cliffs were made safe from predators and their coastal grasslands restored, there would be a very high possibility of prospecting puffin pairs exploiting this suitable habitat, which would lead to the population expanding its breeding grounds and increasing in numbers.

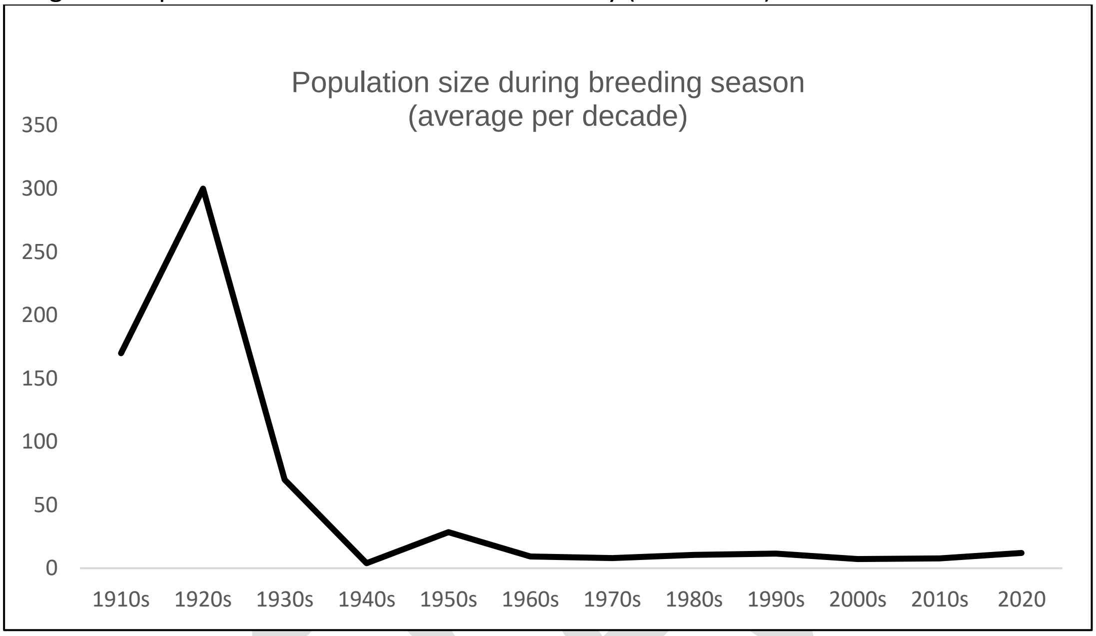
Razorbills

Image 31. A small raft of razorbills below their breeding site in the study area.

Like the puffin, the razorbill belongs to the auk family, spending most of its life at sea and only coming to land in order to breed, where it nests in ledges and rock crevices in cliff faces. The only two breeding locations for razorbills in the Channel Islands are Jersey and Alderney’s islets, although they might have bred occasionally in Sark - and potentially as recently as 2017, when a group of approximately 40 individuals was seen in the vicinity. In Herm there might have also breed occasionally, with nine individuals on the last count in 2015. In Alderney there were 14 individuals in 1970 and again in 2015, although numbers did fluctuate up to 80 during that period[31].

In Jersey the razorbill is considered a rare breeding species. The earliest records, from 1911, estimate a breeding population of 100 individuals, with a maximum estimate of 300 individuals in 1924. After that the species started a steep decline with numbers fluctuating between 20 and 50 individuals for most years, until 1990. Since then the population has numbered less than 20 birds at the breeding site, with a present estimate of eight to ten breeding pairs (Image 32).

Image 32. Population trend of the razorbill in Jersey (1911-2020).

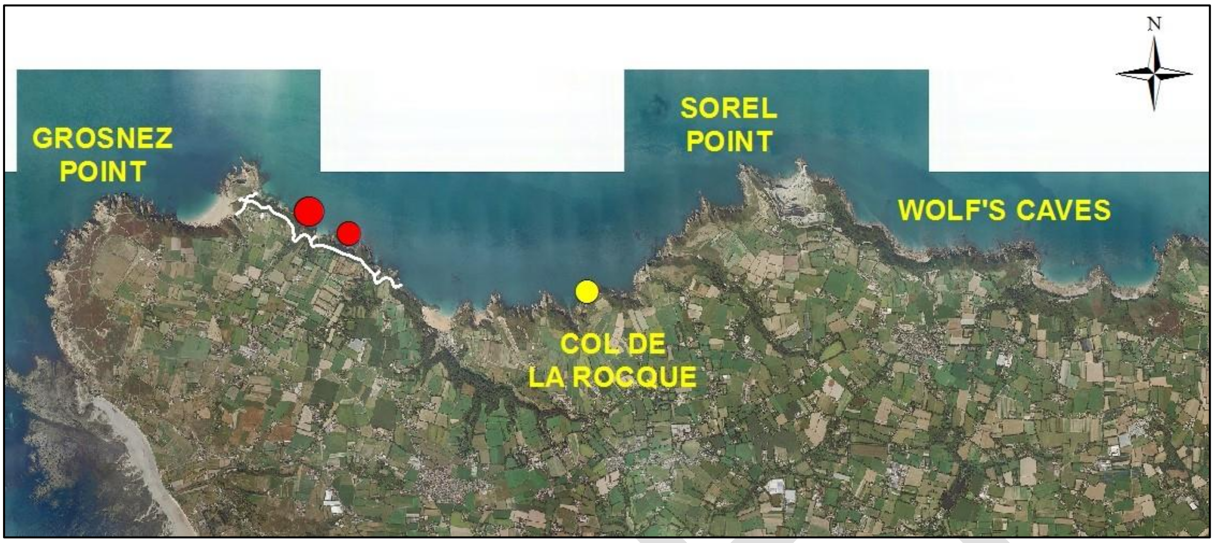


The vast majority of razorbill nests known in Jersey have been and still are within the study area, and would also fall inside the boundaries of the proposed seabird reserve (Image 33).

Image 33. Location of razorbill nests in 2020 (red dots) and boundary of the proposed fence (white).

Records point to a small colony of five to ten pairs near Col de la Rocque between 1934 and 1937. Individuals have also been observed during the breeding season at Grosnez, Sorel point and Wolves' Caves, although breeding has never been confirmed at these sites (Image 34).

Image 34. Location of razorbill nests in 2020 (red dots), previous known breeding site in the 1930s (yellow dot) and other sites with sporadic presence during the breeding season.



Like the puffins, the present population of razorbills is too small to be considered safe from extinction, and is also in the Jersey Red List[33].

Records have shown that Jersey held the largest colony of razorbills in the Channel Islands, and that the cliffs of the north coast were a suitable nesting habitat. The large numbers seen less than a century ago, in the spot where the small breeding colony still remains, point to the ability of this species to utilise the cliffs for nesting and raising their young (Images 37 and 38).

Images 35 and 36. Razorbills standing outside their nests and a razorbill carrying fish to one of the nests in the study area *(Image 36 © Romano da Costa*).

It is believed that the razorbill is well placed to increase in numbers and expand across its former breeding range if the right conditions were met; these would include the removal and long-term exclusion of predators from the area, as well as a degree of management of the disturbance at sea from humans and watercraft.

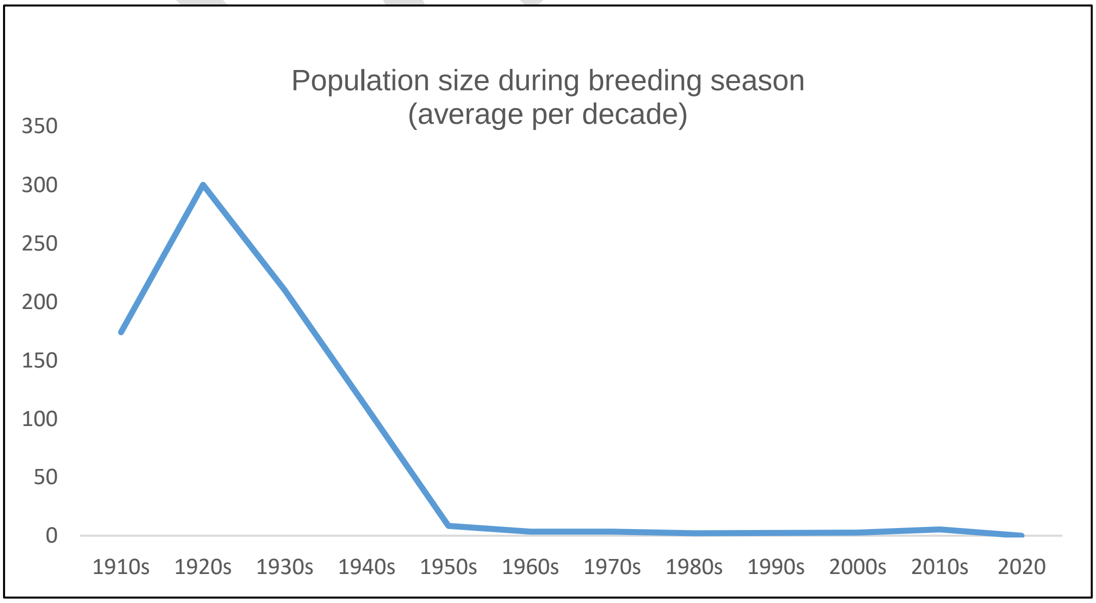
Guillemots

Image 37. A guillemot nearby the razorbill and puffin nesting area.

Another member of the auk family, the common guillemot breeds on ledges and crevices between rocks on steep cliff faces, sometimes sharing the sites with razorbills. Guillemots are a common visitor across the Channel Islands, but presently only breed at two main locations: Sark and Alderney. In Alderney breeding pairs use offshore islets such as Cocque Lihou, with numbers fluctuating between 40 individuals in 1970 to 60 individuals in the 2015 census. Sark holds the largest colony in the Channel Islands, with over 200 individuals counted in 2013 - however recent records might indicate a slow decline, down to an estimated 60-70 individuals in 2020. In Herm numbers have fluctuated between 24 and 90 birds since the 1970 survey, with the last count in 2015 totalling 30 individuals[31].

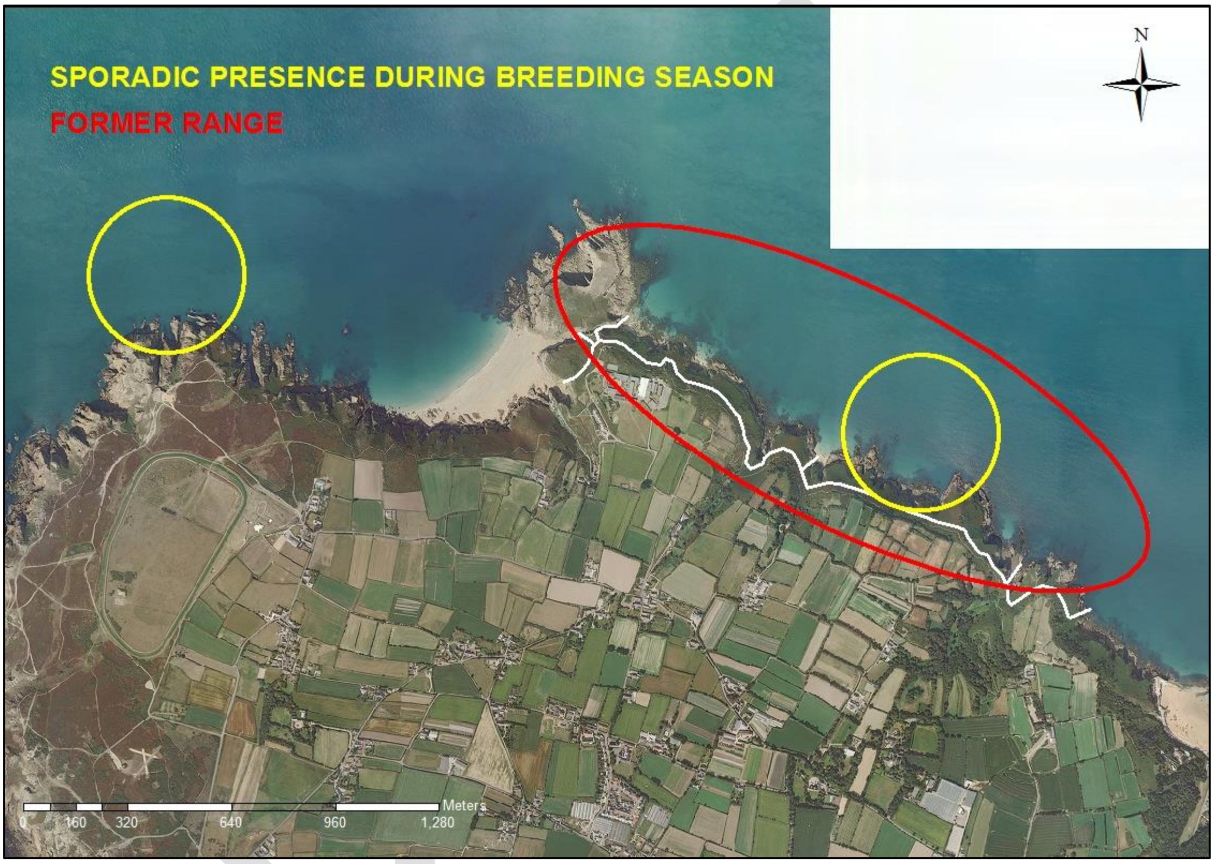
The guillemot is considered extinct in Jersey, but in 1911 it was home to a colony of 200 individuals, which increased to an estimated 300 by 1924. Sadly, the following available record is from ten years later, 1934, and by then the population had dropped to 50 individuals. What followed was a steady decline, with numbers in single figures from the 1950s onwards, and with the last sighting of a guillemot sitting on a nest ledge in Jersey in 1974 (Image 40).

Image 38. Population trend of the guillemot in Jersey (1911-2020).



Like razorbills, all the historical colonies and clusters of guillemot nests in Jersey were found between Plémont and Douet Du Mer, therefore would have fallen within the study area and also inside the boundaries of the proposed reserve. A recent breeding site might have appeared in the last two decades to the west of the study area in Grosnez – that is unless it had been undetected until then. Since the mid 1990s between 1-7 birds have been seen below Grosnez point during the breeding season almost every year, and sometimes observed flying into the cliffs below the castle and lighthouse. Despite the lack of more substantial evidence, it is possible that one or more pairs of guillemots breed in that area unnoticed. Birds are also seen below the cliffs of their former colonies in the study area, where razorbills and puffins still breed, however they have not been observed flying into those cliffs in recent times (Image 41).

Image 39. Guillemot former breeding range in Jersey and locations with sporadic presence in 2020.



The guillemot is a species that could return to its former breeding sites in the proposed reserve. All the management that might be needed is a removal and long-term exclusion of predators from the area, and management of the disturbance at sea from humans and watercraft. The occasional visits to the area by guillemots that approach the cliffs whilst swimming, and the nearby colonies in Sark and Alderney, offer hope that the species can have a future in Jersey.

European storm petrels

Image 40. A storm petrel released after being ringed.

This small petrel, belonging to the Procelariidae family (albatrosses, petrels and shearwaters) is a nocturnal burrowing bird which nests in little holes under grass tufts or crevices between rocks and boulders.

There are no records of storm petrels breeding in the study area, but the species have bred in Jersey in the past, namely in the east coast and the offshore reefs. The first record is from 1951 and it appears that between 1951 and 1961 the species bred regularly, albeit in very small numbers (1 or 2 nests) at Icho Tower, at La Rousse (near Icho Tower), and at Maitre Ile (Les Minquiers). During the ‘70s and ‘80s individuals were observed or trapped (for ringing) occasionally at these locations during breeding season (May to August), however there was not enough evidence to confirm breeding.

Storm petrels have also been heard and trapped by bird ringers at the Plémont headland, during nocturnal survey sessions in July, with a total of 206 birds caught since 1999 (Image 40). Some of these birds might be young individuals from nearby populations in France of other Channel Islands, which might be prospecting for a breeding site to nest.

Ringing records support this statement, with some of the birds trapped at Plémont having been ringed originally at French or British colonies. Birds ringed at Plémont have also been re-caught in Burhou, between 1 and 9 years after their original ringing. The population of Burhou has seen a fast and dramatic increase in the past 20 years, growing from an estimate 60 pairs in 2000 to over 1,000 pairs in 2015. In regards to the other Channel Islands, the species is known to have bred in the north of Herm (Guernsey) up until 1946, and is also considered a former breeder in Sark.

Despite storm petrels being heard and trapped at the Plémont headland, it is believed that the site does not hold any breeding pairs, due to the presence of rats, ferrets and hedgehogs. The playback survey carried out throughout the headland did not detect any burrowing birds either. The fact that the area is visited regularly during the breeding season gives hope that if the site was made secure from predators, the area would have the nesting requirements for the species, and that there would be a surplus of young individuals from nearby colonies ready to colonize the area.

Image 41. Two storm petrels in suitable breeding habitat.

The apparent and rapid increase in the Burhou population over the past 20 years might indicate that this species is very skilled in utilising a suitable area, and that the chances of it breeding in the Reserve soon after it is made safe from predators are probably very high. Conservation projects aimed at helping storm petrels have succeeded with techniques such as rat eradication and by increasing nesting opportunities, for example by creating dry-stone walls[34] and placing ice-cream tubs inside that the birds can use as a burrow.

Manx shearwaters

Image 42. A Manx shearwater released after being caught and ringed.

This is another member of the albatross family, a small shearwater with a dark back and pale belly, and pointy wings adapted for flying close to the surface of the sea. They are also nocturnal and nest mainly on grassland sea-cliffs, where they use rabbit warrens or dig their own burrows (Image 43). If natural cavities are in short supply, they can use artificial burrows connected to the exterior by a short pipe.

Image 43. Manx shearwater breeding habitat in Lundy Island.

The UK has an important role in the conservation of this species, as it is the home of 80% of the world population. It is also the longest living bird in Britain, with the oldest shearwater known, from ringing research, being ten days short of 51 years old.

In the Channel Islands the are scattered records of breeding pairs of Manx shearwater. Records from nation-wide surveys indicate that there were 55 breeding pairs around 1985-88, and 10 in the 1998-2002 survey[31]. The Guernsey islet of Jethou has a traditional site in which possible burrows were identified in 2015. In Sark there is also evidence of breeding, as in 1977 five shearwaters were killed by a ferret, suggesting they were on their breeding grounds[35]. In 2015 a shearwater was found on the ground of a tunnel in April, and in 2016 and 2017 birds were seen offshore close to the island during the breeding season. It is possible that Manx shearwaters also breed in Burhou in small numbers, as some were heard in July 2015 during a nocturnal ringing expedition to the island.

There are no breeding records of Manx shearwaters in Jersey, but there have been sightings in Jersey waters during the breeding season since at least the 1950s. The playback survey in the Plémont headland did not produce any positive results, and the audio recorder set in the headland did not record any individuals in the vicinity; although having only been set up at the end of the breeding season, the chances of birds in the vicinity were very low to start with.

It is very likely that Manx shearwaters do not breed in the study area, mainly due to the presence of invasive predators, however 17 individual birds have been caught during the night-time ringing sessions at the headland since the year 2000. Birds have also been heard calling on these ringing sessions even before a tape was played, which is typically used to entice them to land near the nets. It is possible that these birds were immature individuals searching for suitable land to nest, which is an encouraging sign if future conservation works can remove and exclude invasive predators from the area.

Other Seabirds

The seabird census surveyed all the cliffs between Plémont point and Douet Du Mer cove, carrying out visual checks of nesting pairs early in the season, and of chicks in nests later, to determine productivity. Early checks found nests of fulmar, herring gull, lesser black-backed gull, greater black-backed gull and oystercatcher. Productivity checks found chicks on nests or on land of fulmar, herring gull, lesser black-backed gull, oystercatcher, and European shag (Table 5).

Table 5. Results of the seabird census and productivity survey in the study area in 2020.

	Fulmar	Herring gull	Lesser black-backed gull	Greater black-backed gull	Oyster-catcher	European shag
April: nests	46	15	1	2	2	0
June: nests	77	15	4	0	1	1
July: chicks	10	5	5	0	0	2
Productivity	**0.2**	**0.3**	**5**	**0**	**0**	**2**

The species productivity has been calculated as number of chicks per nests counted in April. It is likely that some of the results are under-estimations, in particular the fulmars, as one of the main breeding areas was visited too soon for chicks to be visible. Only repeated surveys over the long-term will show if the 2020 productivity is close to the annual average for these sub-populations, nevertheless it is likely that methodology needs adjusting, in particular the schedule of visits, in order to obtain more accurate estimates for each species.

Image 44. A lesser black-backed gull with its recently fledged chick.

4.2.2 Land birds

The main source of data on land birds at the study area was the Breeding Bird Survey, which was adapted from the BTO protocols for this purpose. The early survey in May produced 143 birds of 17 species, and the late survey produced 220 individual birds of 23 species. The most abundant species during the early survey was swift, followed by goldfinch, linnet and wren, and on the second survey the most abundant species was wren, followed by swift, jackdaw and linnet (Table 6).

Some of the birds observed were believed to be nesting inside the proposed area of the reserve, particularly cliff-nesters and those strongly associated with coastal habitats, such as swifts, kestrels, jackdaws and rock pipits. Based on their movements and behaviour, it is believed that all the other species observed during the surveys could also be holding territories within or overlapping the reserve area.

Some of the motion-activated cameras in the study area also captured birds on occasion. All were species expected to be in the vicinity of the cameras. The majority of the records belonged to pheasants; in smaller proportion were wrens, robins, blackbirds, magpies, song thrushes, stonechats, linnets, goldfinch, meadow pipits, kestrels, and marsh harriers (Images 45 and 46). With the present location and set up of cameras, this was not considered a reliable method for the long-term monitoring of land birds, but it could be for certain species at certain times.

Table 6. Land birds recorded during the breeding bird survey in 2020.

Species	May	June
Common stonechat	0	2
Meadow Pipit	2	0
Rock Pipit	3	6
Linnet	25	18
Chaffinch	0	9
Goldfinch	30	1
Barn Swallow	6	11
Chiffchaff	0	10
Dartford warbler	1	1
Great tit	1	0
Wren	10	42
Dunnock	5	18
Robin	0	12
Blackbird	1	7
Common kestrel	2	1
Common buzzard	0	1
Magpie	1	4
Western jackdaw	0	23
Carrion crow	8	5
Common raven	0	6
Stock dove	0	1
Rock Dove	1	11
Wood pigeon	3	3
Red billed chough	1	2
Swift	43	26
TOTAL	143	220

Images 45 and 46. A wren and a pheasant on a motion-triggered camera.

4.2.3 Native reptiles and amphibians

There are four species of reptile in Jersey (slow worm, wall lizard, green lizard and grass snake), and three amphibians (common toad, agile frog and palmate newt). Thanks to research carried out by other local projects, the distribution of some of these is well documented, in particular species with a limited range, or species which benefit from targeted conservation management. This is the case of the wall lizard, the grass snake or the agile frog. Potentially, there could be suitable habitats for these three species within the study area, however none of them are known to be present, and were not expected to be found during the survey work.

Green lizards, slow worms, European toads and palmate newts were recorded in the survey area during various types of fieldwork (Image 47). Toads and palmate newts were found breeding at the ponds in the Trust land with hundreds of tadpoles developing in them. A large toad also appeared on camera on one occasion, in a location near two of the ponds.

Slow worms have been directly observed near or on footpaths on the western portion of the study area, including on the open ground near the bunker in the Trust land. Two slow worms have been found freshly dead also in this area, their bodies showing bites and puncture marks, which might indicate a casual attack from a domestic animal such as cat or dog. A 2012 local slow worm survey also detected this species on the eastern quadrant of the study area.

Green lizards are regularly seen near or on the coastal footpath as well as across the Plémont headland. They have also appeared on camera on three occasions at a location near the 'Puffin Village', on the public land below the shooting range.

Image 47. Records and recent observations of reptiles and amphibians in the study area.

Although the Refugia Monitoring Programme could not start in 2020, a total of 20 mats were laid out and much was learnt from the process of surveying suitable spots for them. It is believed that this type of monitoring scheme, already implemented in other sites across the Island, can produce data adequate for long-term monitoring of reptiles, amphibians and even small mammals. It is hoped that this monitoring scheme can start in 2021.

4.2.4 Non-target mammals

Jersey has 11 species of terrestrial mammals, four of which are considered invasive and which are potential predators of native wildlife; those are the target species of this proposed eradication and exclusion. The other eight species are non-target mammals: red squirrel, Jersey bank vole, lesser white-toothed shrew, Millet's shrew, rabbit, wood mouse, house mouse, and mole.

The motion triggered cameras set across the study area captured images of all four invasive predators as well as at least six and a maximum eight of the non-target mammals (Table 7). This uncertainty is due to the difficulty in discerning between the two shrew species and the two mouse species from the images.

The main taxa on camera was mammals, and rabbit was the most abundant species of mammals to appear on camera (Images 48 and 49). Some of the rabbits on camera showed physical signs of the Myxomatosis disease.

All the other mammal species combined added up as many records as birds, with nearly half of the birds on camera being pheasants (Table 8). Dogs have been included in the list, as they appeared slightly more than cats. All dogs were thought to have been pets being walked at the time of the image, whereas it was not possible to ascertain whether cats were feral or pets from a nearby home.

Table 7. Terrestrial mammals in Jersey.

Species	Non-target	On camera
Red squirrel	✓	✓
Jersey bank vole	✓	✓
Shrew spp.	✓	✓
Hedgehog		✓
Rabbit	✓	✓
Brown rat		✓
Feral ferret		✓
Mole	✓	
Mouse spp.	✓	✓
Cat		✓

Images 48 and 49. Rabbits on a motion-triggered camera.

Table 8. Appearances on cameras 1-6 between 2018 and 2020.

TAXA		MAMMALS BREAKDOWN	
Mammals	1273	Rabbit	892
Birds	340	Mouse spp.	141
(of which pheasants)	*155*	Jersey bank vole	121
Reptiles	3	Shrew spp.	28
Amphibians	1	Brown rat	12
		Feral ferret	12
		Unidentified small mammal	12
		European hedgehog	6
		Dog	6
		Cat	4
		Squirrel	1

The distribution of species at the camera sites was not even nor equal (Table 9). Whilst mice and shrews appeared on most cameras, the larger species showed more clear differences in preferences for certain areas, and were absent from others, at least on camera. This could be due, in part, to the exact positioning of each camera, which was not conceived with one particular species in mind, and which might have been more suitable for one species at one site and for another species at another site. However, the differences between presence and abundance of invasive predators at least seemed partially supported by the live-trapping results (see section 4.5 Target species: invasive mammalian predators). The cameras did not capture moles at any of the sites, despite visual evidence of their presence, in particular between camera sites 1 and 2 (Image 51).

Image 50. Jersey bank vole on a motion-triggered camera.

Image 51. Evidence of a mole tunnel near the NTJ pond at Plémont.

Table 9. Distribution of species at the camera sites.

Species	Camera site					
	1	2	3 (trial)	4 (trial)	5	6
Rabbit	✓	✓	✓	✓		✓
Mouse spp.	✓	✓	✓	✓	✓	✓
Shrew spp.	✓				✓	✓
Jersey bank vole	✓	✓		✓	✓	✓
Squirrel				✓		

Image 52. Location and breakdown of the motion-triggered cameras for bait trials and monitoring.

The dusk surveys produced a steady income of data (Table 10). Most of the surveys were completed in three nights, but some had to be repeated a fourth night due to bad weather or disturbance from humans or dogs. Rabbits were usually easy to identify (Image 53), but various other mammals and birds were observed too. Some smaller mammals appeared to be rats or mice, although most were recorded as unidentified. The number of rabbits recorded with this method, and the consistency between survey nights and areas surveyed, is significant enough to warrant the continuation of this technique as a means for monitoring this species in the long term.

Table 10. Number of rabbits at dusk surveys.

Month	Plémont headland	Plémont NTJ land
June	17	34
July	13	35
September	35	26
October	2	9
November	31	15
December	38	42

Image 53. Two rabbits on the thermal imager.

4.3 Conservation value

Islands are disproportionately important for global biodiversity, their ecosystems holding between 15% and 20% of all plant, reptile and bird species. Jersey's biodiversity is unique to the Island, and holds an interesting combination of species from both continental Europe and British Islands. Its proximity to the continent and past physical connection to it has prevented the evolution of true endemic species, although some unique subspecies have emerged such as the Jersey bank vole.

Jersey has many natural areas which are protected in a variety of ways. According to the revised 2011 Island Plan, "The Minister for Planning and Environment has obligations under the Planning and Building (Jersey) Law 2002 and various international conventions to conserve and enhance the Island's biodiversity and to develop public awareness and involvement in conserving it"[36]. These obligations are, in part, met by the identification, designation and protection of sites of wildlife value. These protected sites include the Island's four Ramsar sites, Environmentally Sensitive Areas (ESA) and Sites of Special Interest (SSI)"[37]. Jersey has 28 designated Ecological SSI, one proposed Ecological SSI and 13 Geological SSI. NO part of the study area is within an Ecological or Geological SSI at present. Eight Environmentally Sensitive Areas (ESA) have been defined to represent the main areas of the Island's key habitats[38]. The study area would fall into the "North Coast habitats; especially heathlands, coastal grassland, maritime cliff vegetation and interconnecting habitats".

The study area and proposed reserve site are protected from certain developments by the Island Plan and by being part of the Jersey's Coastal Park. The Government's Natural Environment Department recognises its ecological value with a management regime that aims to enhance its biodiversity, preventing the encroachment of dominant plants such as bracken and bramble, and encouraging a mosaic of coastal grassland, heathland and gorseland, amongst others.

The National Trust for Jersey also regards the area as one of its main conservation priorities. Its Lands team has worked to create a semi-natural habitat on the grounds where the old holiday camp stood, by planting sections with gorse and other native shrubs, creating wildlife ponds, and fencing areas vulnerable to human disturbance. Only two years after the clearing of the site, the Trust has reported that palmate newts and toads have been found in the ponds, whilst around 50 plant species have so far been recorded including wild carrot, toad rush, birds-foot-trefoil and small-flowered catchfly. Due to the origin of the top soil used on the restoration work, maritime duneland plants such as fragrant evening-primrose, sea beet and sea radish have also appeared[39].Wild birds are also being monitored in Trust land with a bi-monthly transect undertaken by the BOTE project officer, as part of a local farmland birds monitoring scheme[40].

In total, the study area is the home for all main groups of native mammals in Jersey, at least two out the four native reptiles, and two out of the three native amphibians. A total of 66 bird species have been recorded on the ground, of which 63 are considered regular breeders in the Island (the total in Jersey is 71 species). Most vertebrates in Jersey are protected by the Conservation of Wildlife (Jersey) Law 2000[41], and a select group of animal and plant species have individual 'biodiversity action plans'[42] in accordance with Jersey's Biodiversity Strategy[43] (see Appendix 1).

In addition to the ecological value of the habitats and natural communities found across the study area, this site is of particular conservation value as the only place in the Island were puffins and razorbills still breed. As both species breed in colonies and respond to visual and vocal social cues, this area has the highest potential to attract new breeding pairs to the Island.

5. THE TARGET SPECIES, IMPACTS AND BENEFITS OF EXCLUSION

5.1 The Target Species

The following are the species of invasive predators found within the study area, all of which represent a threat to puffins and other native wildlife (Table 11).

Table 11. Number and source of records of invasive predators in study area 2018-2020.

	Brown rat	European hedgehog	Feral ferret	Domestic cat
Images from monitoring cameras	12	85	12	2
Images from bait trial cameras	28	6	9	4
Trapping	13	200	36	0
Direct observation	0	0	0	1
TOTAL	**53**	**291**	**57**	**7**
N of individuals (minimum known)	**13**	**32**	**17**	**4**

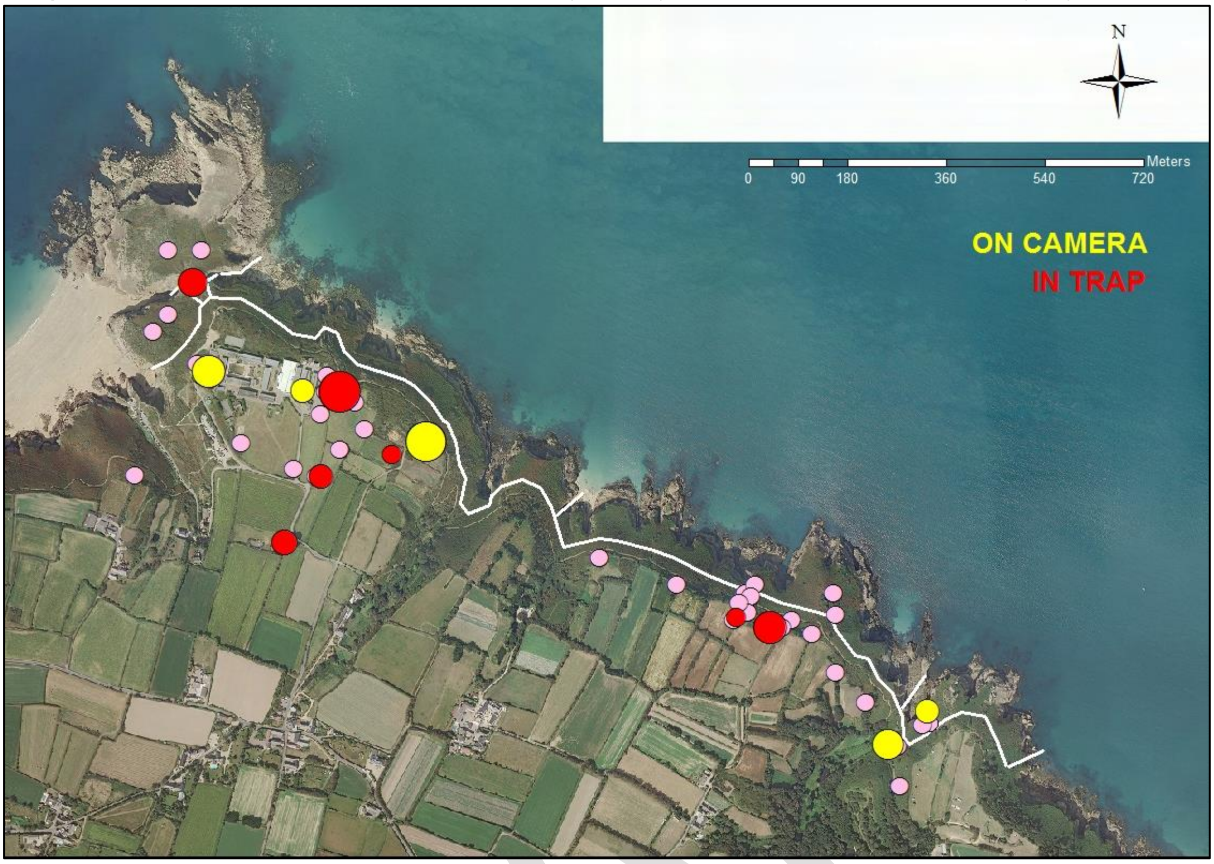
Brown rats

Brown rats were found throughout the study area, with individuals caught on camera, trapped, and observed directly during visits to carry out various different works.

There is a total of 53 records of rats in the study area, with 28 from images during the bait trials, 12 images captured during regular monitoring, and 13 from trappings. Records show a widespread distribution across the study area with one trapping at the entrance to the headland, inside what would be the reserve (Image 55). Rats in the headland have also been often reported by hobbyist anglers that fish there at night, as well as seen directly by the project officer on the roads leading to the Plémont car parks, during dusk surveys.

Image 54. A brown rat on a motion-triggered camera

Image 55. Distribution of brown rats in the study area (yellow and red), location of traps (pink).



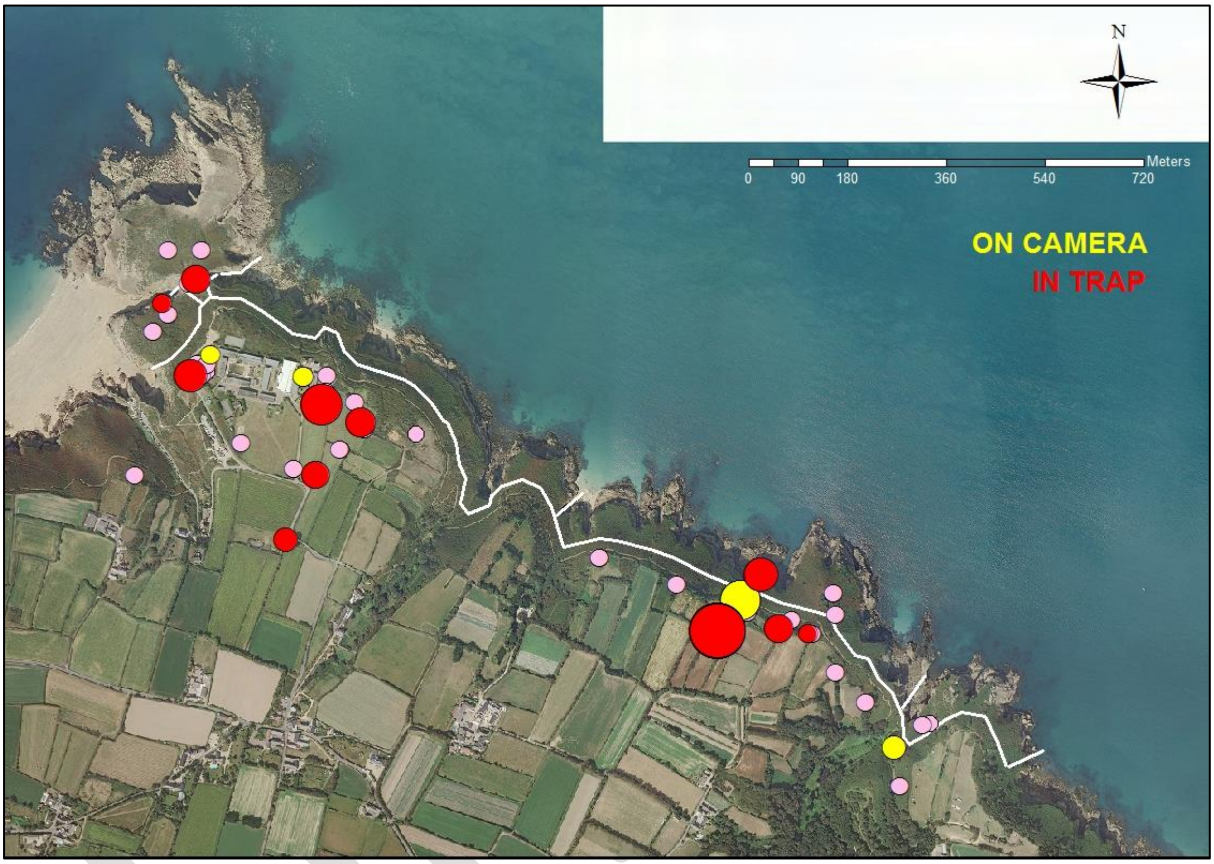
Marking the rats was not possible due to logistical limitations, therefore it is not possible to ascertain how many different individuals the records represent. It is possible that the same rat appeared more than once on camera, especially during the bait trials. It is less likely that the same rat got caught more than once in a trap, as they are considered very intelligent animals with great capacity to learn. This would suggest that each of the 13 times a rat was trapped, it was a new rat. This belief is supported by the fact that on some days up to four rats were trapped in different traps, and that rats trapped in consecutive days in the same trap appeared very different from each other, in size as well as behaviour. The methods did not allow for a clear determination of the sex of each rat, but one was known to be female, as it was found in the trap with eight deceased rat fetuses. It is believed that the rat had suffered a natural abortion while it was inside the trap, and appeared otherwise unharmed.

Image 56. A brown rat in a live trap.

European hedgehogs

The hedgehog was the invasive mammal most recorded in the study area, with a total of 291 records. Of these, 85 were images captured during the bait tests, 6 from regular monitoring and 200 from trapping sessions. Hedgehogs appeared to be widely distributed throughout the study area with some inside the proposed reserve (Image 57).

Image 57. Distribution of European hedgehogs in the study area (yellow and red), location of traps (pink).



Hedgehogs were not marked at the first six of the total 200 trappings; therefore, it is not possible to know if they were six different individuals or less. Unmarked hedgehogs were marked with an individual code at all the trappings afterwards. Thanks to this technique most trapped hedgehogs were identified and their longevity and movements between traps was tracked during the time of the study. Results indicated at least 31 different individuals, most of which were trapped more than once. Adding the first six trappings which were not marked, this would give a population estimate of 32-38 individuals. The hedgehog with the longest running record at the time of writing was H6, marked for the first time in November 2018 and trapped for the last time in September 2020 (Images 58 and 59).

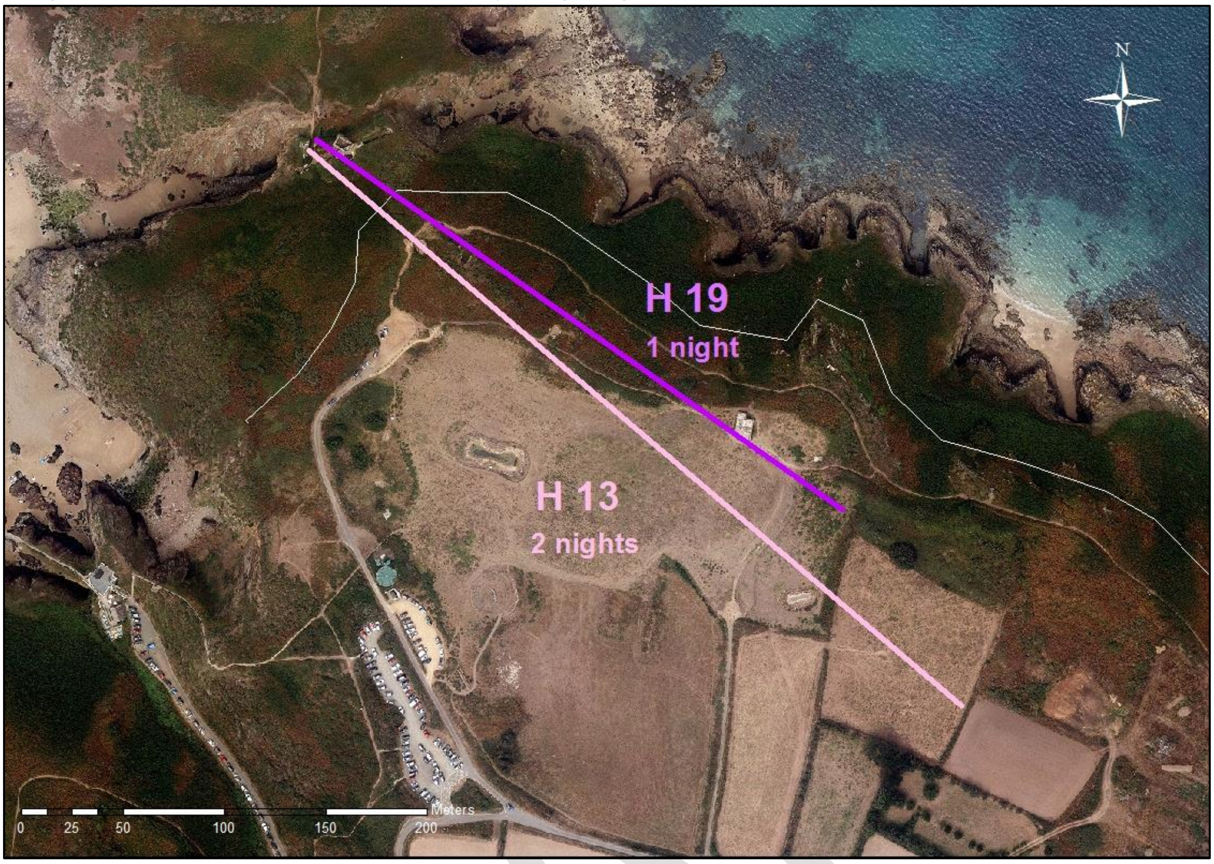
Image 58. Hedgehog H6 being weighed before release.

All hedgehogs were examined to determine their sex, which in some cases was possible. Behaviour and injuries were also noted, which mostly consisted of sections of damaged spines consistent with hedge strimmer cuts (Image 59).

Image 59. Hedgehog H6 showing its colour mark (deep purple) as well as a strimmer injury on the centre spikes.

The re-trapping of marked individuals also allowed to determine the movements of the hedgehogs between traps during the 5-day trapping sessions and between sessions. The longest distance covered in one night was 316m by H19 (on a straight line), 102 meters short of the distance covered by H13 in two nights (Image 60). Both of these hedgehogs were found inside the reserve.

Image 60. Minimum distances travelled by hedgehogs H19 and H13 based on start and end location.



Another hedgehog, H17, might not have travelled very far, but it visited almost every trap in a particular area within a period of six months (Image 61).

Image 61. Locations of hedgehog H17 within a period of six months.

Feral ferrets

A total of 58 records of feral ferrets were produced from research involving bait trials, long-term monitoring cameras and trapping sessions. An even larger body of information was collected by radio-tracking some of the ferrets that were captured in the live traps. The first ferret to be trapped was taken to the JSPCA, as it was caught during the trial period and there was no research protocol in place. All the ferrets trapped afterwards were marked and released (as were found in good health). The ferrets were marked with numbered ear tags or with a radio-collar; or both. A total of 17 different ferrets was found in the study area, including the first one which was taken to the JSPCA. This ferret was a male. The other 16 ferrets trapped during the long-term monitoring were eight females and eight males. Males were often found with bite marks and small wounds around their necks and backs, especially during the mating season, which were consistent with territorial fights between males. Two females were found at different times with swollen nipples and vulvas, as well as bites on the neck – all potential signs of sexual maturity and breeding status. At different times during the research period two of the marked ferrets, upon re-trapping, appeared to be in poor health, and were taken to the JSPCA as per established protocols. None of the ferrets taken to the JSPCA were to be released back into the wild.

Ferrets were mainly trapped in the western half of the study area, where most of the images from motion-triggered cameras also came from. However, two cameras caught ferrets on the eastern edge of the study area and within the proposed seabird reserve. On two of these occasions, a ferret was photographed at the very edge of the first ‘Puffin Village’, where artificial burrows and decoys have been installed in an area of cleared bracken (Image 62).

Image 62. Distribution of feral ferrets in the study area (yellow and red), location of traps (pink).

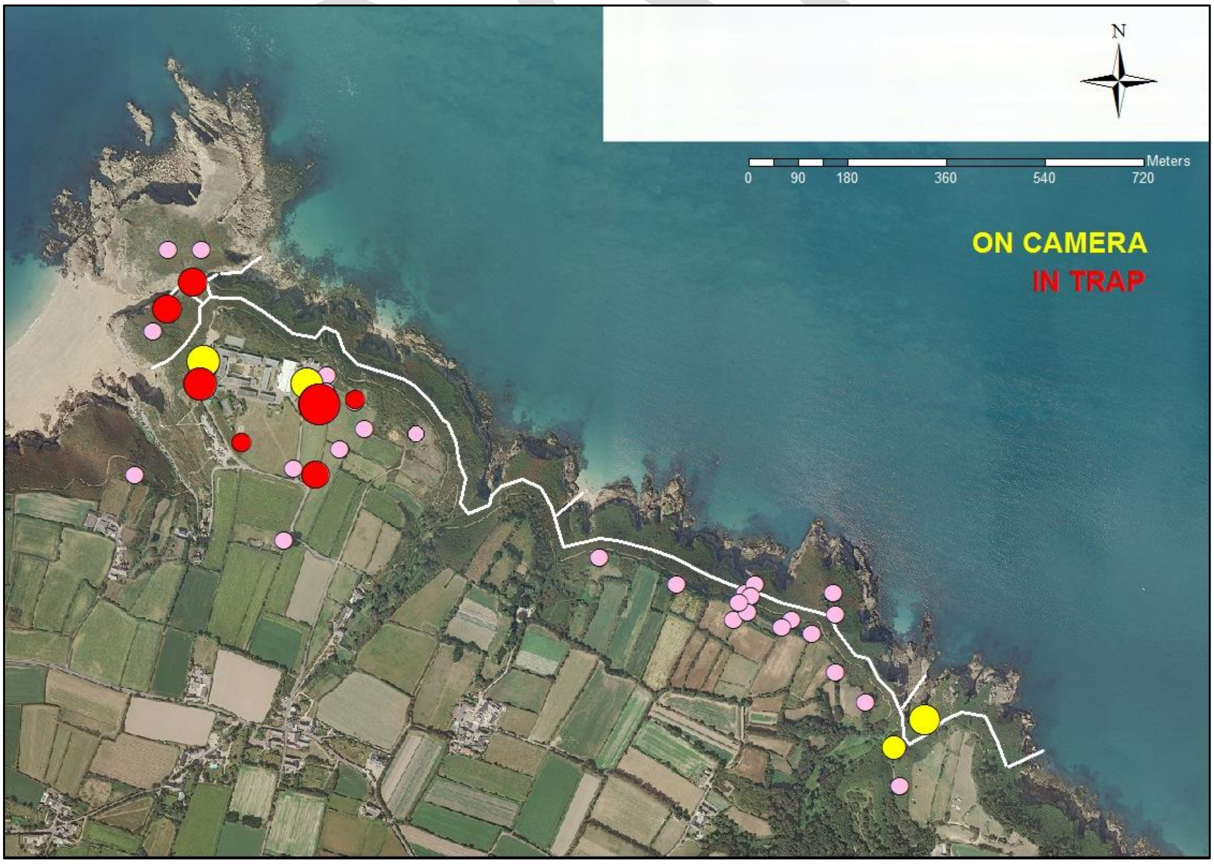


Image 63. Two ferrets trapped on the same day before release.

Twelve ferrets were radio-tracked for a period between 1 and 360 days. Radio-tracking revealed, in some cases, large ranges of movement outside the study area (Image 65), with ferrets travelling over 1,000 meters from the edge of the reserve in various directions. A total of 53 dens were identified, with 11 of them found inside the proposed reserve, which was visited by several of the tracked ferrets. In some cases, an individual appeared to be resting in the same den where another ferret had been the night before, an occasionally two ferrets appeared to be in the same den at the same time.

Image 64. Ferret wearing a radio-collar before release.

Image 65. Locations of the dens identified (red dots) and proposed fence boundary (white).

Due to the radio signals being faint or disappearing on many occasions, probably due to the terrain, walls and buildings, it was not possible to locate each ferret every day, therefore is not possible to know for certain their exact home range. However, when the signal permitted, the movements of some ferrets could be mapped in the space of months, weeks and even consecutive days. The ferret which appear to travel further and faster, according to the locations that could be determined, was ferret F9, a male who seemingly covered long stretches in short spaces of time and who held the largest radio-tracking range overall (1,7400 meters on a straight line) (Image 66). Ferret F13 also travelled far from the reserve (over 1,000 meters from the edge), spending most of her time in a human-built environment, in dens on field banks by roads and stables, and under wood piles in private gardens (Image 69).

Other ferrets, in particular F15 and F16, were often found using a very large burrow in the Plémont headland, in between stays at the NTJ restored land and in the small valley opposite, above the road to Plémont Bay (Image 6770).

Image 66. A selection of locations of ferrets F9 and F13 in relation to the proposed fence boundary.

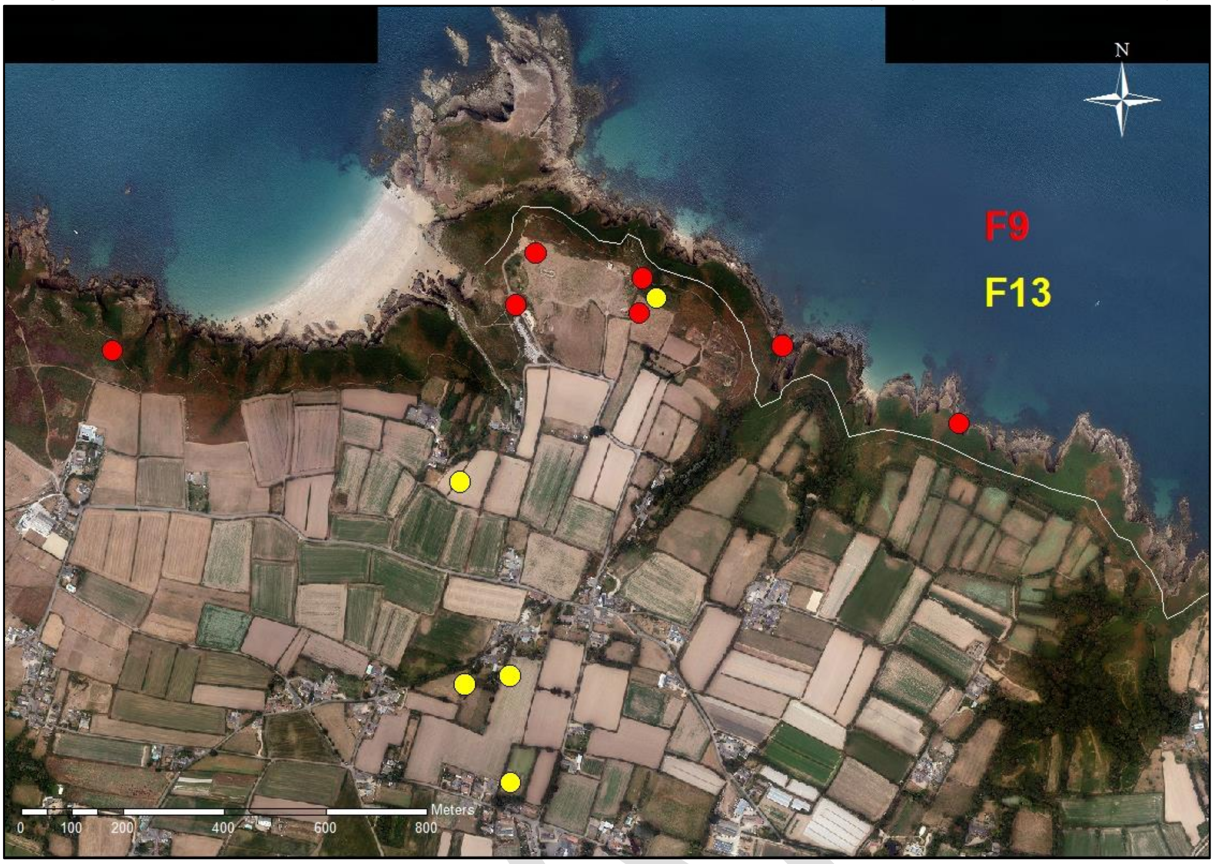
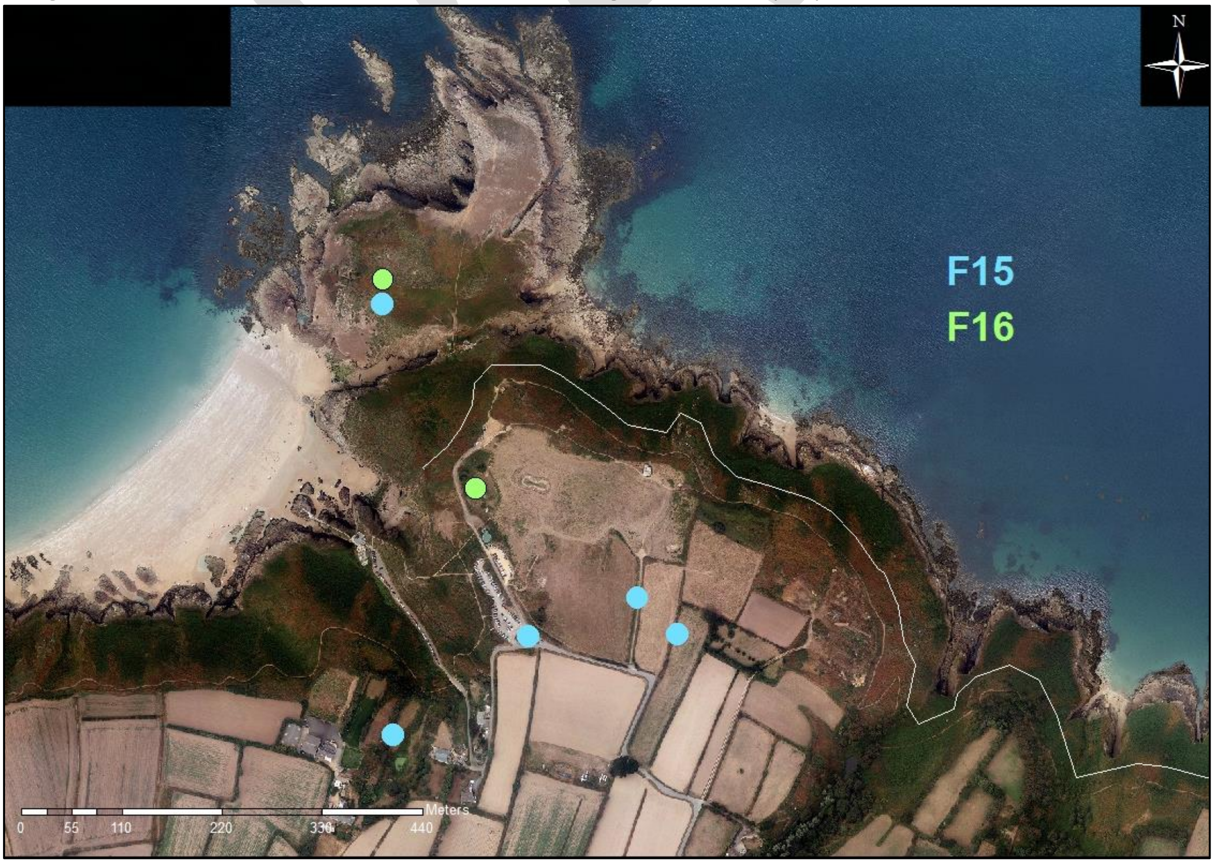


Image 67. Locations of ferrets F15 and F16 including visits to the proposed reserve area.



All dens were photographed and notes were taken on the vegetation, habitat type and tracks present (Images 68 and 69). Some dens appeared to be part of large rabbit warrens, and rabbit droppings were found often at the entrances of the burrows.

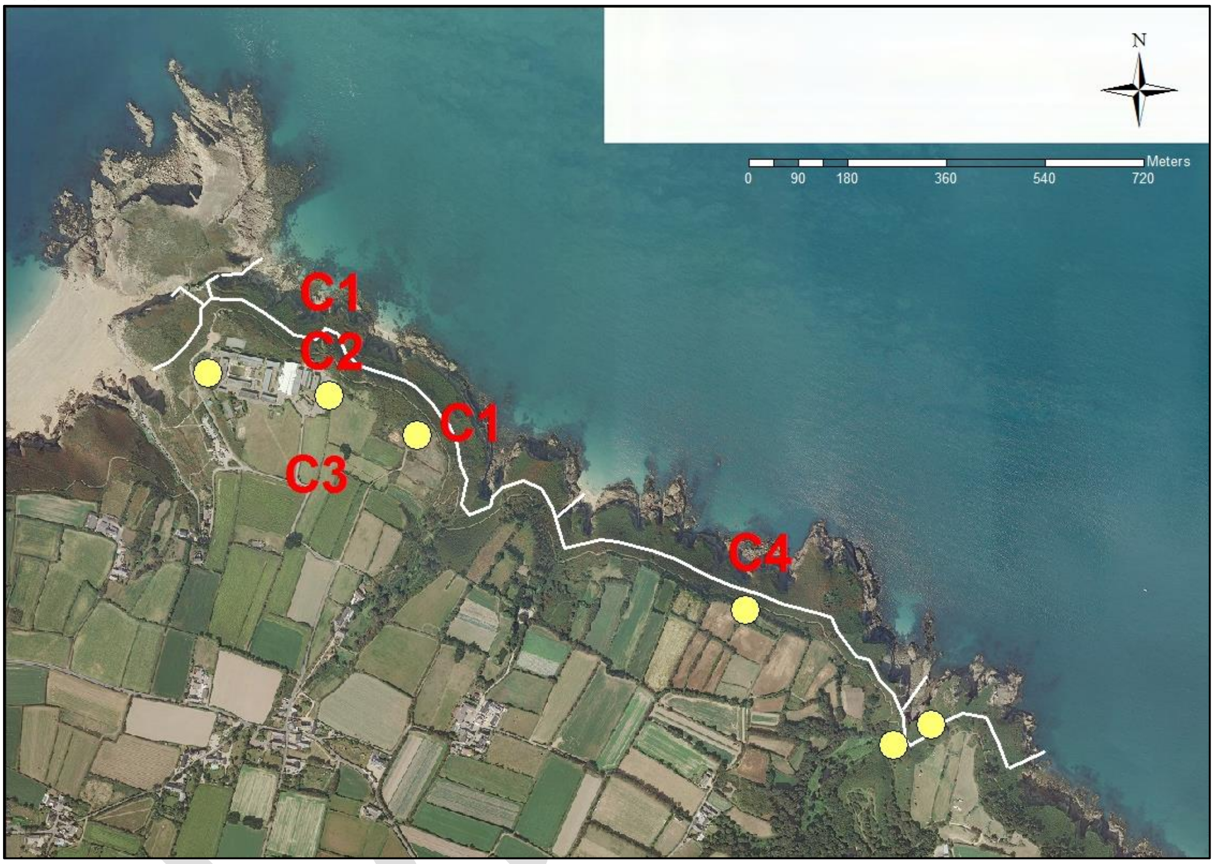
Image 68. A large rabbit warren with multiple entrances where various ferrets were located at different times.

Image 69. A den located in a bank on the edge of a horse field in a built-up area.

Cats

No cats were caught during trapping sessions, although this was expected as the live-traps were not intended for a species of this particular size and habits. However, cats were detected across the study area in sites far from each other, in low densities. Most of the records came from the motion-triggered cameras, and in another instance a cat was directly observed by the project officer whilst working in the area. Two of the images were captured during the bait trials phase, and the other four images were taken during the non-baited long-term monitoring phase (Image 70).

Image 70. Location and identification of cats recorded in the study area (red) and location of motion-triggered cameras (yellow).



A visual check of the markings and coloration of the cats' coats indicated that there were at least four different cats (Image 71). It is not known if the cats caught on camera were feral or pets from a household in the vicinity. However, the cat which was encountered by the project officer seemed quite tame and relaxed, and allowed the officer to pet it (Image 72).

Images 71 and 72. A cat on a motion-triggered camera and a cat encountered by the project officer.

5.2 Impacts of the Invasive Mammalian Predators

There is a vast and varied body of evidence documenting the negative impact of invasive species on wildlife communities and their habitats[44, 45], which are disproportionally larger on islands[46]. This is due to the fact that island species have evolved without the presence of mammals, and therefore have no natural defences against them.

The arrival of invasive mammalians to islands happened intentionally or accidentally when humans took them to newly-discovered islands around the globe. These introductions have had devastating consequences, particularly on ground-nesting birds[47]. Globally, invasive predators have caused two thirds of all recorded animal extinctions[48] and approximately 42% of all known bird extinctions[49].

There are many invasive species present in the UK, the exact number not known with certainty as estimates vary according to definitions used. However, their impacts and the effectiveness of control measures are known and have been documented extensively[50].

Brown rat

The brown rat, also known as the Norway rat, is a rodent with brown fur on the back and pale grey fur on its belly. In the UK, male rats have a mean home range of 678m, with that of females being smaller[51]. The adults weigh 150 - 300g, although they may reach up to 500g. In Europe, the brown rat exists primarily in close relationship with humans, but there are also ‘wild’ populations along water edges. The brown rat is considered to be territorial throughout most of the year, but they will spread when food is scarce, and migrations have been observed. Rats rarely climb trees, but can cross large bodies of open water comfortably such as mudflats, intermediate rocky islets and tidal flows[52]. Females are polyestrous and ovulate spontaneously, with breeding determined by food availability. Litter size is 6 - 11, and females can be sexually active in the season of their birth.

Their diet is omnivorous and they are opportunistic feeders - including raw or cooked meat, vegetable matter, grains and other seeds, berries, roots, a wide variety of vertebrates (fish, shellfish, reptiles, birds and birds’ eggs), and invertebrates (beetles, spiders, and flies). Brown rats have also been known to attack and kill young rabbits[53,54].

Rats are generally considered as the most successful invasive animal in modern times, having spread across the globe alongside humans. There are three rat species who have dominated this expansion: the brown rat, the black or ship rat, and the Pacific rat. Brown rats originated in China and spread across Europe during the 15th Century. From there, the species reached the Americas, Australia and Africa, as well as to island groups, via boats - being accidentally transported in cargo or stowing away on vessels. Once an island was colonised, the species could move throughout an archipelago by hitch-hiking boats as well as via natural dispersal, as they are capable of swimming up to 2.5km[56]. The latest data indicates that the brown rat is found in 36% of the world’s island groups[5].

The arrival of rats to islands have caused extinctions and breakdowns of natural communities, disrupting ecosystem functions through predation of animals and plants, causing direct or indirect knock-on effects through interruption of pollination, nutrient pathways, and seed predation, causing forest collapse in the most extreme cases[8].

Extinction, or severe threat of extinction by rats, has been catalogued from the tropics to sub-Artic and sub-Antarctic islands[5,9,57]. The brown rat and the black rat are believed to have caused 40-60% of all bird and reptile extinctions on islands, with the brown rat alone responsible for the decline or extinction of the largest number of indigenous vertebrates: 60 species so far.

European hedgehog

This species is native to western Europe and can be found from Italy and Spain to southern Scandinavia. An adult can vary in weight between 600-700g in the spring to up to 1500g in the autumn, before their winter hibernation. They have few natural predators thanks to the over 7000 spines on their back and crown of the head, protecting them from threats when the animal rolls into a ball. They are nocturnal and solitary, with males often fighting if in close proximity of each other.

The females can have up to two litters of 4-5 young each year, with the female raising the litter alone. Litters can be larger in colder climates. The average lifespan is of 3-4 years although some individuals have been known to live up to ten years. Hedgehogs are omnivorous, preferring a diet of invertebrates such as beetles, caterpillars, earthworms, slugs and earwigs, but they can switch if other prey becomes more accessible, such as frogs, snakes, mice and shrews. The eggs and chicks of ground nesting birds are also an attractive source of food when available[58].

Humans have introduced hedgehog populations outside of their natural range for a variety of reasons, from controlling slugs and other crop pests (in UK offshore islands) to act as a reminder of the settlers' homeland (in New Zealand in the 1870s).

The extent to which hedgehogs impact upon the New Zealand environment is only beginning to be understood. They are now known to be a major predator on eggs of riverbed breeding birds as well as of a variety of ground-nesting birds, and in some areas are responsible for one in five predator attacks on nests. The species is not only threatening native birds but also many endemic invertebrates, reptiles and amphibians. For these reasons the species is considered a nation-wide pest and is part or many ground-trapping programmes across the country[59].

In the UK hedgehogs are listed as 'priority species' and 'species of principal importance' on the national Biodiversity Action Plan, as the species has declined over the last 60 years from 30 million to less than one million. However, in the UK's offshore islands they have been an invasive species since their introduction by humans in the 1970s. A single pair brought to North Ronaldsay grew to a population of 1000 hedgehogs in only 12 years. Similar introductions have resulted in hedgehogs being found at in the Orkney Islands, Shetlands and the Isles of Scilly, where they mostly survive at densities higher than in their native habitats. This is probably due to the lack of some of their natural predators, like the European badgers, and the fact that climate change is leading to more favourable conditions for hedgehogs on islands.

This lack of predators and competitors has led to very high levels of predation by hedgehogs on the eggs of ground-nesting birds: on one island hedgehogs were found to cause a 39% decline in breeding shorebirds over ten years, and were responsible for up to 50% of all breeding failures.

In another island (South Uist, Scotland) hedgehogs were introduced to control slugs and snails in gardens. A group of four individuals released in 1974 had grown to a population which averaged 2750 individuals per year by 2006. A study found that hedgehogs predated up to 60% of the nests of some waders, and their density did not appear regulated or diminished by the subsequent wader declines. The study concluded that local extinctions of susceptible wader species were likely if no action was taken to reduce hedgehog predation[60]. The effects of the removal of hedgehogs was tested using fenced enclosures, showing that the breeding success of waders inside the plots (where hedgehog densities were zero or low) was approximately 2.4 times that of birds nesting in adjacent control areas (where hedgehog densities were high)[61].

Feral Ferret

The ferret is the domestic form of the polecat, a member of the weasel family (Mustelidae). Depending on the interpretation of its origins, it is referred to as *Mustela putorius* (European polecat), *Mustela putorius furo* (subspecies or descendant of the European polecat), or simply *Mustela furo*. Feral ferrets and European polecats hybridise where their ranges overlap, and the hybrids are often indistinguishable from the wild polecat[62,63].

Ferrets were first known in Palestine some 1000 years BC, where they were used for hunting rodents and hunting rabbits. They have been known in Europe since at least the Middle Ages[64] and in the 1970s begun to gain popularity as pets in many parts of the world[65].

Ferrets are sexually dimorphic, with males being much larger than females (between 1000-2000g in weight, 600-900g for females)[66]. They have a long and slender body, which measures 48cm-60cm long including the tail. They have large canine teeth, and each paw has a set of five non-retractable claws[67].

Ferrets are largely nocturnal, and spend the day resting in crevices, hollow logs, other animal's burrows or dens that they dig themselves. Their home ranges vary in size depending on many environmental conditions, such as terrain and prey density. In New Zealand's high country, home ranges are 100–120 hectares for males and 80–100 hectares for females. In the lowlands, males have home ranges of 30 hectares and females of 12 hectares[68]. In Europe feral ferrets are found in many habitats, such as dune systems which are the home to large rabbit populations. Den sites can be found in gorse, dense scrub, rabbit holes, buildings, rubbish piles, and hay barns[69,70].

In Europe, rabbits are the main prey of feral ferrets, but they also eat birds, even when rabbits are plentiful[70]. Ferrets are capable of switching to other prey when rabbit numbers decrease[71] and will prey on hares, possums, bird eggs, lizards, hedgehogs, frogs, eels and invertebrates. They are known to scavenge the carcasses of other ferrets, hedgehogs, cats and possums, and even lambs in the Scottish Isles. Some seasonal variation in diet has also been observed: rabbits and hares are preferred in summer, and rodents in autumn and winter. Birds are eaten all year round, but more in spring and summer[71].

Ferrets have been introduced accidentally in the wild as escapees from ferreters and pet owners, but have also been introduced intentionally to control rabbits. This invasive predator threatens a wide variety of native wildlife in any place where it has been introduced: Europe, North America, Australia and New Zealand amongst others. Native wildlife threatened by ferrets includes ground nesting and flightless birds in New Zealand[72,73], seabird populations on the Azores[74], and bird populations in the Scottish Isles, to name a few[75].

It is believed that ferrets have been in Jersey since at least the 1970s, originally brought by people with the purpose of hunting rabbits. Nowadays ferrets are kept in Jersey as pets, as well as still used for hunting in some parts of the Island. The present feral population is believed to have originated from escaped or released animals, and it is probably self-sustaining or increasing; recruitment happening from animals breeding in the wild, as well as from captive ferrets escaping or going missing in small numbers. Feral ferrets are known to attack poultry and domestic waterfowl, and even pet rabbits on occasion[76]. Local pest controllers are licensed to trap and humanely destroy them if required.

Cat

The cat is the domesticated descendant of the African wildcat, and thanks to its association with humans it has established itself in almost every environment that people have colonised. Feral cats are usually smaller than their domestic counterparts, averaging 1.5-3.0kg, although can grow up to 5kg. Despite the various breeds generated by human selection, feral cats tend to revert to physical types closer to wild ancestors, such as black, tabby or tortoiseshell.

Cats are intensive breeders. A female cat reaches reproductive maturity between 7 to 12 months of age, and can reproduce any month of the year if food and habitat is adequate. A female may produce three litters per year[77], with an average litter of four to six kittens[78].

Feral cats in the wild have adapted to a variety of habitats, such as forests and woodlands, fields, grassland, riparian habitats and even tussock grassland in a sub-Antarctic island[79]. Their mean home range is usually larger for males than females, and dependant on prey availability. When comparing domestic cats to feral cats the differences are significant: an Australian study determined a mean home range of 7 to 28 hectares for domestic cats, whilst it was just short of 250 hectares for feral cats. In New Zealand some home ranges of feral cats were as large as 985 hectares.

Cats arrived to all continents via ships, being carried intentionally to control rat infestations. They were also taken by humans as pets and subsequently escaped or were left behind in islands. The diet of feral cats on islands may be different to that of their mainland counterparts, with many cats often taking advantage of alternative food sources. Besides many species of seabirds, they have been recorded to prey on indigenous invertebrates, hatchlings of green turtle, black rats, flying foxes, and even birds as large as themselves, such as frigate birds, pelicans and flightless cormorants[80,81].

Cats are considered among the top ten worlds' most invasive species[82]. Their effects on native species are widespread, especially on islands, where they have caused at least 14% of all the bird, mammal and reptile extinctions[83]. Of the 63 species of birds, mammals and reptiles that cats have brought to extinction, 33 were found in islands. In a well-known case, a single cat caused the extinction of a whole species, the endemic Steven's Island wren[83]. On islands native predators are few or non-existent, and potential prey is abundant, so cats can increase to form large and dense populations. The estimated mortality caused by cats in Marion Island, for example, stands at 450,000 seabirds per year[84], and at Kerguelen Island at 1.2 million seabirds per year[85].

5.3 Benefits of Removal and Exclusion of Mammalian Invasive Predators

Given the well-documented impact of invasive predators on seabirds and other native wildlife[9], conservations efforts that have focused on the eradication of these threats from islands worldwide have produced significant and positive results. New techniques developed have prompted renewed efforts to control or eradicate introduced mammals[86], and the application of good ecological principles and practice has become paramount to maximise the success of such intense management[87].

Conservationists in New Zealand, Australia, America and the Pacific have a great tradition of mammal eradications from islands and have established a vast pool of techniques and expertise. By 2010 New Zealand had seen 147 populations of 13 species of invasive vertebrates removed from a least 95 islands with a total area of 32,000 ha. The benefits to biodiversity from those eradications included improved prospects for 16 species of invertebrates, two species of frogs, three taxa of tuatara, 23 species of lizards, 32 taxa of terrestrial birds and 16 taxa of seabirds. In Western Mexico, the eradication of black rats from 5 islands resulted in the protection of 46 seabird populations[88]. At Midway Atoll National Wildlife Refuge, Bonin petrel populations increased from less than 5000 pairs in the 1980s to over 135,000 pairs in 2008 after the eradications of rats in 1997[89].

Globally, a review found that 251 eradications of invasive mammals on 181 islands has benefitted 236 native species[90]. A later study identified and ranked a further 292 of the most important islands where eradicating invasive mammals would benefit highly threatened vertebrates. It was determined that eradication of invasives was socio-politically feasible in 169 of these islands, and that it would improve the survival prospects of 9.4% of the Earth's most highly threatened insular vertebrates (111 of 1,184 species)[90].

Closer to Jersey, various island eradications have been completed successfully in British Islands, with StAgnes and Gugh of the Isles of Scilly being declared rat-free in 2016, and the Shiant Islands in Scotland in 2018. The benefits of eradications have already been documented in other islands such as Ramsay, Wales, where rats were eradicated during the winter of 1999/2000. In Ramsay populations of Manx Shearwater increased from 849 pairs before the eradication to 4,796 pairs in 2016, and Storm Petrels, which had been previously absent, established a small colony which in 2016 had at least 12 pairs. In the cliffs of Lundy Island about 3,500 puffins used to breed in the 1930's, but had been reduced to only 13 puffins by 2001 due to rat predation. Manx Shearwaters had also reached a low 297 individuals. The eradication of rats from Lundy, carried out from 2002 to 2004, allowed both species to recover, and by 2019 there were 375 puffins and 5,504 Manx shearwaters in Lundy.

The benefits of removing and excluding invasive predators from around the Jersey puffin colony are expected to be positive both ecologically and socio-economically. Even though the direct impact of predation is not easily observed at present, historical records point to most of the damage being done in the past decades, with the remnant population of puffins and other seabirds being physically limited to the cliffs most inaccessible to the terrestrial predators. This, paired with their low densities, makes them a difficult prey to access, and therefore of low priority to potential predators.

There is a small possibility that this status quo, of small and stable populations, will be maintained at perpetuity. However, evidence has shown that small populations are disproportionately more vulnerable to random chance events which precipitate extinction. This is reflected in the fact that most species that go extinct do so by suffering a string of unfortunate events, such as fire, storms, heavy rainfalls, extreme temperature changes, diseases, or even an unusual increase in predation, which exterminate the last individuals of a colony. Large populations, in contrast, usually hold a wider range of individual variations which prevent such random events from killing all individuals at once, allowing for some to survive and re-build the population. Moreover, the Jersey puffin has been placed in the Jersey Red List of birds of conservation concern, which echoes locally the IUCN classification and which recognises a 'small but stable population' (of less than 50 individuals) to be Critically Endangered.

The Jersey puffins would benefit from a chance to increase in numbers in order to make the population more resilient to random events. This situation, paired with the negative effect that the invasive predators are known to have on terrestrial native wildlife, makes a case for removing and excluding all invasive non-native terrestrial mammal predators from the area.

If we establish that the presence of predators in the area is impeding the expansion of the small colony, and the re-colonisation of other extirpated species, to otherwise suitable habitat, we would conclude that the removal and exclusion of these predators will result in the expansion and increase of puffins, as well as other native seabirds, land birds, reptiles, amphibians, mammals and invertebrates.

Key benefits of removing invasive predators include:

- Returning this area in the north coast partly towards its natural state, free of all introduced mammals. The gross result is expected to be positive, especially if all four target species are removed simultaneously.
- Providing safe and suitable breeding habitat for the surviving colonies of puffins and razorbills, giving them room to expand safely.
- Protecting all other seabird species in the area.
- Allowing the recovery of locally extinct species such as the guillemot and the storm petrel.
- Allowing the natural colonization of species that breed in the English Channel such as the Manx shearwater, or that could potentially breed in the Channel such as the Balearic shearwater.
- Allowing the recovery of a wide range of terrestrial vertebrates and invertebrates, particularly those associated with coastal grassland, heathland and gorseland.
- Restoring ecological food chains and webs, allowing native plant communities to recover free of unnatural influences such as grazing from rats.
- Protecting terrestrial bird species in the area, allowing their expansion and increase.
- Protecting many other native vertebrates such as green lizard, bank vole and shrews.
- Management of dominant plant species such as bracken and control of its expansion with grazing flocks.
- Creating a safe biological reservoir where other native species can be translocated into. This could be useful to create populations of species with limited range in the Island, such as the wall lizard, or to translocate and head-start populations which might become endangered at their present ranges. It can also be used, if necessary, to generate a Myxomatosis-free sub-population of rabbits or to study the disease in an enclosed population.

Social and economical benefits:

- A significant step in acquiring local expertise and experience in managing vulnerable native species and their threats, and as a means of furthering local skills and capacity-building.
- Supporting economic activity in the Island with the use of local contractors, producers and suppliers, including a shepherd for the grazing flock.
- Offering training and apprenticeships, via the main contractor's own trainee and student bursary scheme, and the Government's Back To Work scheme.
- Providing learning opportunities for students of institutions such as JICAS.
- Creating internships in the field of ecological monitoring and management for local students.
- Promoting collaboration with local businesses such as cafes, shops, birdwatching guides and other leisure operators via our awareness campaigns and interpretation materials.

The hospitality, leisure and tourism sectors will also directly benefit from an increase of biodiversity and public interest in the area.

It is not possible to foresee all potential negative effects of the project effects of the project, however it will be paramount to prepare a list as comprehensive as possible, to assess the potential effects and to prepare mitigation measures. Table 12 summarizes a preliminary list of effects and their potential mitigations.

Table 12. Potential negative effects, assessment and mitigation.

Potential negative effect	Assessment and mitigation
Risk of partial failure with one or more species surviving eradication	Best practice and adequate resourcing will maximize prospects for success, repeated attempts at eradication until completed.
Risk of re-invasion	Biosecurity measures in place with ongoing feedback and adjusting of protocols.
Risk to some non-target species through use of toxins or traps	Scenarios are largely predictable and avoidable based on experience and best practice protocols. Effects will be short-termed and monitored, and most likely off-set by long-term gains.
Potential isolation of small mammal and reptile populations inside the fenced area	Monitoring long-term, with potential management options in place such as translocations in either direction, but likely that populations will be fine as area is large and ecological balance will re-set itself. Possible increase of natural predators of small vertebrates such as kestrels, buzzards, marsh harriers, crows and ravens.
Lack of predation results in an increase of rabbits and subsequent increase of grazing pressure leads to changes in plant community	Some changes in vegetations will be welcome due to the dominant nature of species such as bracken, bramble and gorse. Increase in rabbits and rabbit kits pups will be capped by increase in predation from their natural predators such as buzzards, marsh harriers and ravens. Monitoring long term in place, which will advice if and when reduction of rabbits is needed. These techniques might involve non-lethal and lethal methods, and should be agreed with government and licencing authorities.

6. FEASIBILITY ANALYSIS

6.1 Technical feasibility

The basic principles to achieving a successful eradication of an invasive mammal are:

- All individuals of the target species must be removed or put at risk by the methods used.
- All target species must be removed at a rate faster than they can reproduce.
- The risk or reinvasion must be zero or must be managed effectively.

The proposed methods to achieve this are, in order of implementation:

Phase 1. Construction of a predator-exclusion fence around the puffin colony.
Phase 2. Removal of any invasive mammalian predators present within the fenced area.
Phase 3. Establishment of a biosecurity strategy to prevent reinvasion (See *Section 6.2 Sustainable*).

Additionally, all monitoring of target and non-target species is to be continued as per the methodologies and recommendations from section 4.1.

6.1.1 Construction of a predator-exclusion fence

Pest-proof and predator-exclusion fences have been used in conservation projects in New Zealand, Australia, Hawaii, the Azores and many other islands, generating a wealth of experience and technical knowledge on their costs, installation and long-term management.

Requirements for an effective fence

Fences that have succeeded in excluding invasive mammals have the following specifications in common:

- 1.9 metres high (as cats can jump over 1.7m unassisted).
- A hood or cap (to prevent mammals from climbing over the fence).
- A mesh square no wider than 7 mm (to exclude juvenile rats or mice).
- An underground skirt extending at least 350mm from the base of the fence (to prevent burrowing under the fence).
- To sit on a level platform (to prevent water run-off).
- Four metres clear of vegetation or other structures outside of the fence. No trees should overhang the fence.

The general design of this type of fence is shown in Image 73. This design uses either anodised aluminium or timber posts; aluminium posts can prevent damage by termites or seawater.

Image 73. General pest and predator-proof fence design*. © Dep. of Conservation, NZ, Bell 2014.*

Whilst is it generally possible to build a fence anywhere, the exact location and design will depend on the target species, terrain, waterways and access requirements. Structurally speaking, the fence must be able to withstand the environmental conditions of Jersey, which will include heavy rainfall and storms. The average rainfall in Jersey is 875mm/year (Jersey Met Climate Statistics, 1981-2010), with the wetter season being from September to March. The prevalent winds are westerly, with an annual average speed of 15.2mph (data from Jersey Airport and Weatherspark statistics, 1980-2016). The Island can occasionally experience violent storms (64-72mph, Beaufort scale) which can be accompanied by gusts of hurricane-strength winds (73mph and over). Structural integrity of the fence has been a particular problem for fences exposed to strong winds and hurricanes, such as the case of the Corvo seabird project in the Azores (T.Pipa *pers. comm*.). It is believed that the weather conditions and the type of exposure are more favourable at the Jersey site.

Within the proposed reserve, there are two small seasonal waterways that led onto the sea from coastal valleys. In order for the fence to be effective, waterways must be sealed to prevent invasive species from obtaining access into the reserve, especially rats who often use waterways to move between areas using the cover these areas provide. At the point of the streams, the fence can be fitted with swinging water gates, so that as water pressure builds, the gates open to allow water through without adversely affecting the fence. These gates can be fitted with alarms to automatically indicate that they have been opened allowing staff to check the fence. Alternatively, culverts with fixed screens can be placed in small waterways through or adjacent to the fence. One of the most important aspects is the continued water management at the site. It is important to assess the issues of water flow at the site to ensure that the excess water does not undermine the integrity of the fence. It may be necessary to test the local flood conditions at the site to determine maximum flow and timing to ensure the fence design has scope to deal with these events. Any breach by water (or vegetation) will allow the reinvasion of invasive species, particularly rodents.

Ideally, the ground would be flat or with a gentle slope, to allow the fence to sit on top of a platform at least four metres wide to provide space for the fence, vehicle access (for monitoring) and drainage (for surface run-off). The strip at either side of the fence would need to be kept clear of vegetation and any other structures.

It might not be possible to have a four-metre platform along the whole fence due to the terrain and slope, but at these difficult spots it will still be possible to install and maintain the fence by other means. Issues arising from the management of stream gates and damage from fallen trees can be pre-emptively mitigated by choosing a route that reduces the potential impact of these issues.

Access into the area protected by a pest-proof fence requires at least one entry gate. This is either a half-gate that people step over while the base portion of the fence remains intact, or a lockable double-gate system that allows vehicle, pedestrian or livestock access. An alarm system can be established if both gates are opened at the same time. The type of gates used at different points of the fence will depend on the requirements of that particular access point.

The integrity of the fence can be compromised by the effects of animals, vegetation, inanimate objects, and accidental or deliberate human action. There will need to be a damage detection system; this can include physical checks by staff, alarms installed which will trigger automatically when there is a breach, and even security cameras if vandalism of theft are a potential problem. Community engagement work will hopefully instil a sense of pride and ownership in the population; this will be of great benefit for the long-term sustainability of the project (see Section 6.3).

Location and route options

The proposed location of the fence would place it below the public footpath and above most of the cliffs and headlands between the shooting range and Plémont headland. The approximate length of the fence would be 2,938 metres and the protected area would total 32.3 hectares (Image 74).

Image 74. Proposed location of the predator-exclusion fence at the Plémont Seabird Reserve.

If the terrain allows it, the reserve would have four sections, to match topographic features as well as to separate land by legal ownership. The sections will also give the advantage to slow down re-invasions to core areas, as they are more likely to happen from either end of the fence, and will allow the management team to deal with incursions in a more effective and quick manner. The partition of the fenced area based on topography and ownership also opens the possibility to build the fence in stages, protecting one or more sections at a time (Image 75). However, it will be more cost-effective to build the totality of the fence at once. Table 13 summarizes the characteristics and features of each section.

Image 75. Proposed location of the predator-proof fence and partitions for four optional sections.

Table 13. Reserve sections (from west to east).

	Plémont headland	Plémont to Creux Gabourel	Vinchelez common	Le Rocquerel
Puffins: Presence / Potential if protected	Absent Very high	Present Very high	Present Very high	Absent Good
Razorbills potential	Absent High	Present Very high	Present Very high	Absent Good
Guillemots potential	Absent High	Absent Very high	Absent Very high	Absent Good
Manx Shearwaters potential	Absent Very high	Absent Very high	Absent Very high	Absent Good
Storm Petrels potential	Absent Very high	Absent High	Absent High	Absent Good

Habitat management	Ongoing	No	Ongoing at 'puffin village'	Ongoing at 'puffin village'
Human activity level (on land)	High	Very low or none	Low	Very low or none
Notes	Habitat in good condition for most target species, their absence probably reflects the presence of predators and humans	Habitat needs mainly bracken management, high potential for many target species	Habitat needs mainly bracken management, high potential for many target species	Habitat needs mainly bracken management, high potential for many target species
Fence length (m)	526	1,069	915	428
Protected area (m²)	141,570	69,129	83,359	29,229
Ratio: m² protected per metre of fence	269.1	64.6	91.1	69.2

Pest-proof fences are expensive to construct, requiring a high initial investment and a long-term commitment to ensure integrity and biosecurity. For every hectare conserved, a larger fenced area is generally more cost-effective than a smaller one[91]; and for every meter of fence built, a headland is more cost-effective to protect than a length of coastline. This makes the Plémont headland the section of the reserve most cost effective to protect (Image 76). However, even a relatively small fenced area will be more cost effective than ongoing control of invasive animals in an unfenced area.

Image 76. Plémont headland as seen from land.

Although it is difficult to assess the lifespan of the pest-proof fence in Jersey, evidence from other fences around the world suggests that a well-maintained fence in a coastal or high salt-prone area could last up to 30 years, depending on the materials used. Although the proposed site has sections of steep cliffs and rugged terrain, it is feasible to construct on it a predator-exclusion fence (Image 77). It would then be possible, using current eradication techniques and supporting technology, to remove the invasive species from within the newly created seabird reserve.

Image 77. Example of a predator-exclusion fence in a coastal area.

6.2.2 Removal of invasive mammalian predators

There are increasing numbers of successful eradications, especially of introduced mammals. The range of species eradicated increases as new techniques are perfected, with for example 21 different species of introduced mammals eradicated alone from 17 islands in the Galapagos archipelago off Ecuador[92]. Species eradicated at other sites include foxes[93], mice, ship rats, Pacific rats, cats, rabbits, goats, and pigs.

As determined by the field studies, all target species have been detected in the study area, and all except the cat have been detected inside of what would be the proposed reserve area. All four target species have been the subject of successful eradications in other islands. The operational plans, methodologies and biosecurity strategies from such projects are available for consultation and can be adapted to local populations and environmental conditions. It is likely that by the time the fence is installed the density of invasive predators will be lower than at present, as the construction works, likely to be in place for 4-6 months, might drive away from the area some of the target animals, making them retreat to other parts of their territories. This will reduce numbers inside the fenced area and will also reduce the costs of eradication.

Monitoring of both target species and native wildlife will continue throughout eradication works, to help ascertain changes in the density of target species as the removal progresses. In regards to live trapping, Jersey has an established protocol on how to process feral cats and ferrets. In the case of cats, it involves trapping the animal humanely and handing it over to licenced organisations such as the Jersey Society for the Prevention of Cruelty to Animals (JSPCA) and the Cat Action Trust Jersey. These organisations are professionally recognized to find the owner of an escaped pet, or in the case of a feral animal, to evaluate its health and character in order to make a decision on its outcome; be it euthanasia or re-homing. Ferrets are classified as pests in Jersey and, although they can be taken to the JSPCA for evaluation and possible re-homing, they can also be humanely euthanized by a licenced pest controller. The guidelines for the removal protocols will be detailed in the operational plan for the eradication and relevant risk assessments that will be produced in preparation of this work.

Brown rats

Over fifty decades of rat eradications have made New Zealand the home of global experts on this matter. There, a string of local extinctions of island endemics caused by rats in the 1960s' prompted the start of formal work to eradicate rats. Since then, teams of wildlife managers, ecologists and scientists have designed, tested and perfected a wide array of methods to successfully eradicate rats from islands; techniques and knowledge which has been useful all around the world ever since[108,109].

It is surprising and perhaps unexpected then, that the first documented successful rodent eradication, in 1951, happened not far from Jersey at all: it was in Rouzic Island (Île Rouzic), in the Sept-Îles archipelago off Brittany and less that 60 miles from Jersey[94]. This, like many other early eradications, were generally an unintentional effect of normal rodent control; however, their unanticipated results prompted efforts to investigate and develop eradication methods.

Nowadays there is a vast reservoir of literature and technical resources on the subject, as much has been learnt from decades of control programmes around the world. Success in removing rats from islands has been achieved from the Mediterranean to the Antarctic, from the smallest islands, such as Maria Island, New Zealand, with 1 hectare, eradicated in 1960, to what once was thought to be an impossible, unsurmountable task: South Georgia, in the South Atlantic, spanning over 352,800ha, where the largest eradication project to date took place, and which was declared rat-free in 2018.

Worldwide, there have been 332 successful rodent eradications to date, with invasive rodents eradicated from 284 islands. With the exception of two islands, all the successful campaigns have used rodenticides as the main or only method of eradication.

For the task of eradication, the type and scale of techniques has evolved from the most traditional trapping (with live or kill traps, which generally fails to remove all individuals due to the species avoidance behaviour), to the most common and cost-effective method: rodenticide-poisoned bait. The efficiency, secondary effects and environmental effects of various types of bait have been evaluated in several field trials, as well as the behavioural responses to different designs of bait station. Besides these two methods of control, other avenues of research are exploring the effectiveness of contraceptive methods, and there are several formulations in development which may make one day oral immunisation a possibility[95].

As it is the case for most traditional eradications, the cost and effort involved increases rapidly as the target population decreases, and the most difficult individual to be trapped or killed is usually the last one. A single animal, especially in the case of a rat, is likely to display atypical behaviour, due to the lack of conspecifics which are a source of reference behaviour and competition for resources, amongst others. Therefore, the last individual of a population might be less likely to investigate a trap or bait station, and might also have less need to, since it has no competition for other more available and natural sources of food[96,97].

The recommended strategy for rat eradication involves a combination of techniques that will complement each other in terms of removal, monitoring of population changes, and detecting remaining individuals.

Recommended strategy for rat removal:

a) Determining and monitoring the presence of brown rats within the fenced area via a combination of baited camera traps, rodent detector cards (Goodnature®), dusk surveys and searches for tracks and signs.

b) Deploying feeding stations with live traps in areas where rats have been trapped in the past, in other locations where they have been detected by surveys and in additional locations which are deemed suitable for rats.

c) Deploying bait stations in areas where rats have been trapped or detected, as well as on a grid of 25-50m squares.

d) Deploying kill traps (Goodnature® A24-type) specific for rats, where rats have been trapped or detected, as well as on a grid of 25-50m squares.

European hedgehogs

Hedgehogs have been successfully eradicated from the Uists Islands, Scotland, in what is so far the only known attempt at eradicating this species from an island group. After determining that the hedgehogs were present in both islands, and were responsible for 52% of all predation in South Uist, The Uist Wader Project was set up in 2000 to remove all the hedgehogs from the Uists. Various methods for monitoring and trapping were trialed and improved, including lamping, motion-activated cameras, footprint tunnels, sniffer dogs and live traps. Furthermore, a trial eradication was carried out to estimate the costs and efforts of scaling up the work to encompass both islands, and an Index of Abundance (IOA) was developed using footprint tunnel data, in order to monitor the impact of the removal activities on the hedgehog population[61]. At the early stages of the project the hedgehogs that were caught were humanely euthanized, but this drew criticism from some sectors of the general public, due to the fact that the species is native in mainland and is popular amongst gardeners and nature enthusiasts. An agreement was reached with stakeholder organizations and authorities that established a protocol whereby the trapped hedgehogs were released in the mainland by a licensed organisation. The number of trapped hedgehogs declined steadily until only one was trapped in 2017; this rate suggested that eradication could be confirmed by end of 2020.

The success in the Uists gives us reason to believe that it is also possible to remove all hedgehogs from the seabird reserve once the fence is installed. The area us much smaller and the number of hedgehogs in it is very small and potentially null. Even though we might not need to implement all the techniques developed by the Uist Wader Project, the lessons learnt by this project, technically and socially, are helping plan and guide the implementation of the hedgehog removal in the seabird reserve.

Recommended strategy for hedgehog removal:

e) Determining and monitoring the presence of hedgehogs within the fenced area via a combination of baited camera traps, dusk surveys and searches for tracks and signs.

f) Deploying feeding stations with humane traps in areas where hedgehogs have been trapped in the past, in other locations where they have been detected by surveys and in additional locations which are deemed suitable for hedgehogs.

g) All hedgehogs caught will have a health check (weight, shape, breeding status). Hedgehogs which appear in good health will be released at the closest suitable point outside of the reserve. If the individual is marked, it will be released at the point closest to its last known location outside of the reserve.

Feral ferrets

The impact of feral ferrets on native wildlife is a problem for conservationists worldwide. Many techniques have been tried to curb their effect, from changing their behaviour to reducing their numbers or modifying their habitat. In New Zealand, the traditional method has been by trapping and culling, although poison has also been found to be a suitable alternative[98]. A bait station that is used by ferrets but which excludes dogs and cats has been developed, alongside various palatable baits which can integrate the poisonous chemicals[99]. In the Orkney Islands there is presently an ambitious project underway which aims to eradicate all stoats from the archipelago. The stoats is a relative of the polecat and ferret, and having been introduced in the islands by humans, the result has been a decline of many native species and in particular ground-nesting birds. The Orkney Native Wildlife Project is using a team of 20-25 staff and over 7000 lethal traps to achieve complete eradication. The skills and field techniques gained by this project can potentially be of great help to the Seabird Reserve Project[100].

Other methods that have been tried include conditioning ferrets to avoid certain prey species[101], or modifying the habitat surrounding bird breeding sites, by planting buffer zones of long grass around breeding sites on coastal grassland. These techniques have had mixed results, as the present view is that habitat modification has a limited applicability for farmland areas[102]. The potential suitable habitats are near or adjacent to agricultural fields, therefore it would not be possible to implement this technique at the site.

Many lessons learnt from projects in New Zealand can be applied to the removal of feral ferrets from the reserve, including the fact that bait is most effective when laid in late summer, autumn and early winter, and that ferrets are overall more difficult to trap in the spring[103,104]. The experience gained by the author during the field work carried out from 2018 to 2020, in particular the work involving trapping and radio-tracking feral ferrets in the study area, will also help implement this eradication plan in an effective and safe manner.

Recommended strategy for feral ferret removal:

a) Determining and monitoring the presence of feral ferrets within the fenced area via a combination of baited camera traps, dusk surveys and searches for tracks and signs.

b) Deploying feeding stations with humane traps in areas where ferrets have been trapped in the past, in other locations where they have been detected by surveys, and in additional locations which are deemed suitable for ferrets.

c) Handing over any trapped ferrets to a licenced organisation in the understanding that should the animal be re-homed, it would also be neutered and micro-chipped, and would not be re-homed in the north-west part of the island (parishes of St Ouen and St Mary).

Cats

The status of cats as pets and domestic animals in most countries raises moral dilemmas on how to manage their impact when they threaten native wildlife, despite the approximately 275 million animals killed by 9 million cats in Britain alone[105]. Even so, cats have been successfully eradicated from many islands with the help of various methods.

Feral cats have been successfully eradicated from islands in all the world's oceans, including some large, remote and challenging places such as Faure (Australia, 5,241ha) and Marion Island (South African sub Antarctic, 29,000ha). The Database of Island Invasive Species Eradications[106] lists 130 cat eradication projects, of which 106 were successful on first attempt and many more have been successful after being re-attempted. These eradications used a variety of methods, sometimes implemented in combination, such as leg-hold traps, hunting, poisoning, cage traps, and dogs. In New Zealand all cat eradications have eventually been successful, and the country's Department of Conservation has produced a 'best practice' draft document for eradication of feral cats from islands which will improve the prospects and efficiency of any future eradications.

Recommended strategy for feral cat removal:

a) Determining and monitoring the presence of cats within the fenced area via a combination baited camera traps, dusk surveys and searches for tracks and signs.

b) Deploying feeding stations with humane cat traps in areas where cats have been detected as well as a grid of potential cat travel routes.

c) Handing over any trapped cat to a licenced organisation in the understanding that should the animal be re-homed, it would also be neutered and micro-chipped, and would not be re-homed in the north-west part of the island (parishes of St Ouen and St Mary).

These three main actions are to be implemented simultaneously and for the period that is deemed necessary at the time. The number of cats likely to be in the area is small or null, as the species has not been detected in the proposed reserve area. Their presence is also likely to be further reduced during the construction works, hence no cats will be expected to be found inside the reserve. However, monitoring will be carried out as per the operational plan, and subsequent biosecurity protocols will guide the response if a cat were to be encountered.

Overall likelihood of eradication success

Standing on the body of reference from the cumulative experience from hundreds of successful eradications worldwide, combined with local and national expertise from similar British projects, there is no reason to believe that a full eradication of the four target species would not be successful, especially if undertaken in a properly resourced and professional manner. As with all eradications, success cannot be guaranteed, but if the best practice is are applied and scaled locally, and the adequate resources are made available, a positive outcome would be expected.

6.2 Sustainability

The concept of sustainability is understood, in this context, as the ability to maintain the seabird reserve free of invasive mammalian predators after the installation of the fence and eradication.

This will entail minimizing the risk of re-invasion by the species that have been removed from the reserve as well as of new invasive species which might become a threat in the future. Managing these risks requires putting in place effective biosecurity measures to cover not only aspects relating to the physical environment of the reserve, but also the socio-cultural and political environment. All these measures will be detailed in the biosecurity strategy, but in brief they will aim to:

A. Prevent invasion or re-invasion by long-term passive means.
B. Detect any invasion via ongoing monitoring and surveillance.
C. React to any invasion with a response to ensure the removal of the invader.

The biosecurity strategy will look into detail at all potential risks of re-invasion, by species and pathways, and will lay out a plan to prevent, detect and eradicate each of them with feasible management options.

At present the land and sea that would comprise the Seabird Reserve have clear pathways of access; the main one is by land, but can also be accessed by any landing craft coming from the sea. Once the fence has been installed, the most likely mechanism for mammalian predators to re-invade will be through damage or malfunction of the fence, accidental transport via sea by humans, or via sea by directly swimming from land adjacent to the reserve (Table 14).

Table 14. Potential invasive pathways for the Seabird Reserve and summary of prevention strategies.

By Land	**Risk (Low/Medium/High)**	**Prevention strategy**
Damage in fence.	Medium, but highly dependent on size, location and origin of damage (i.e. weather, debris, accident). Rats and hedgehogs might be more prone to exploit damage near the ground, whilst ferrets likely to be wearier, and cats less likely to cross a newly-formed aperture.	Routine visual checks on fence integrity. Response protocol and contingency budget to repair damage in the fence as soon as it is detected.
Malfunction of fence gates.	Low, as design will comprise a double-gate security system which is unlikely to fail on both gates at the same time.	Routine visual checks on gates. Motion-activated cameras in the vicinity of gates to detect possible malfunctions and incursions from target species.
Accidental release via gates.	Low, as it would be unlikely that any of the target species would cross unnoticed the double-gate system when in use.	Awareness campaigns and clear signaling on proper operating of gates. Motion-activated cameras in the vicinity of gates to detect accidental incursions from target species.

Intentional release via gates.	Low, but depending on positive community and awareness work.	Awareness campaigns and positive community engagement. Motion-activated cameras in the vicinity of gates to detect intentional releases of target species.
By Sea	**Risk (Low/Medium/High)**	**Prevention strategy**
Accidental introduction from boats approaching, mooring or landing on the reserve.	Low for hedgehogs, ferrets and cats, as they are likely to be noticed in a boat and they are not likely to abandon a ship and swim to shore. Medium or high for rats, as they are less likely to be noticed on a ship and can swim on open water, but also dependent on the type of ship and the state of the sea at the time.	Awareness campaigns for leisure craft owners. Facilitation of checks and response protocols for commercial fisheries operators. Review of mooring and landing regulations in the Seabird Protection Zone.
Swimming from land adjacent to fenced reserve.	Low for hedgehogs, ferrets and cats, as they are less likely to swim across open water. Medium for rats, as they can swim confidently on open water.	Rodent bait and traps near the ends of the reserve, at both sides of the fence where it meets the sea. Motion-activated cameras at the ends of the fence to detect target species venturing into the sea.

The seabird reserve, like any other natural protected area, cannot be made totally secure from potential reinvasion, as some events will be beyond the control of managers and authorities. However, many pathways can be effectively managed with the implementation of a robust biosecurity strategy.

The advantages that the reserve will have towards its biosecurity is that there already exists a high level of public awareness on local nature conservation and that there is support of the local community to habitat and species restoration work, as well as a sense of local pride on the natural heritage of the island. The public and authorities are also aware of the health and economic benefits associated with the restoration of wild landscapes, and the local businesses that operate in the area (tour operators and commercial fisheries) support this project and have indicated their interest in collaborating on the production and implementation of the biosecurity strategy. Furthermore, the area features mainly steep cliffs, rocky headlands and prevalent swells, which lessens the interest and likelihood of recreational visitors to moor near or land on the reserve.

6.3 Social acceptability

The final goal to all conservation projects is to benefit the human population, whether directly or indirectly. But even though the result of a project will have an overall positive impact, the response of the local community can be very varied and will depend on how the project affects their economic, cultural and historical values. Furthermore, no conservation work is ever free from some negative impact, be it to non-target species or to aspects of the locals' way of life. A negative impact is often subjective and depends on the persons' or organisation values upon the project site and its natural community.

The support and engagement of the local community is critical for the success of any project, from the planning and implementation phase to the long-term sustainability of this effort. In order to secure this support, it is paramount to involve the community at a very early stage – this will not only help understand, prepare, minimise and mitigate any negative impacts of the community, but might also help identify any impacts not foreseen by the management of the project. It is indeed the importance of this local knowledge and positive engagement which will conduit towards a real participation and sense of ownership of the project from the local community.

In the case of eradication initiatives, these is usually a positive reaction from the local community, as it has likely suffered the direct effects of the invasive species, especially if it is a rodent. The impacts might have been direct, via depletion of natural resources, attacks on crops or vectors of disease; or indirect, via loss of income from tourist and hospitality venues due to predation on key species and degradation of habitats. In those cases, the public response to the eradication initiative tends to be of engagement and support. In the case of predator-proof fences, there is a smaller body of tradition and expertise on their implementation. Some of the issues of concern might be matters of visual impact, access, and long-term management. Most projects involving a predator-proof fence have succeeded by engaging a strong base of community support, with public consultations, education campaigns and ongoing activity programmes.

In Jersey there might be, too, concerns in regards to the visual impact of the fence. These will be addressed firstly by landscaping the fence within its natural environment and placing as much of it as possible below the line of sight from the public footpath. This issue will also be addressed during informal discussions that have already started as part of the public consultation process (Image 78). Another potential concern might be that of access during the installation works or even after the fence is completed. The planned reserve has few spots which are visited by the public: the Plémont headland (for a variety of leisure activities) and two other smaller, less accessible sites (mainly for the purpose of angling). Access to all these spots might be reduced during certain times of the installation process, but it will be regained in the long-term via access gates, which will hopefully address the concerns on this matter (Image 79).

Image 78. Example of a predator-exclusion fence below the line of sight.

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Image 78. Example of an access gate on a predator-proof fence.

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The eradication, translocation or removal of the invasive species is likely to be met with mixed responses. There is the potential for some emotive reactions amongst sectors of the wider public to the suggestion of using lethal methods for eradication, or to restricting hedgehogs from parts of their ranges. Either of these options have not been formally decided and other courses of action remain open, although it is important to educate on the different costs and time scales involved on each option.

It is almost certain that there would be some negative effects on some of the non-target species. If bait is used as one of the methods to remove rats from the reserve, its effects on the community will be short-lived. The effects of a fence will also impact on populations of non-target mammals and reptiles. The implications and mitigations of this impact are reviewed in detail in Section 6.5. Managers and field professionals involved in ground-level conservation work have to be pragmatic about such matters, whilst making informed decisions that balance the goals of a project against its negative impacts. Members of the general public, if the are more detached from this process, might express concern about the effects on non-target species. There might even be a broader debate over the relative merit and priority of creating this seabird reserve, however preliminary responses show an inclination by most consulted to support the protection of Jersey's puffins and other local seabirds, based mainly on a sense of pride for the Island's natural heritage as well as enjoyment of an iconic and charismatic species at such accessible spot.

The consultation process for the Seabird Reserve has to focus on the installation of the fence and subsequent eradication of invasives from within. It needs to prioritise a transversal inclusion of all groups and interested parties, and present in a clear manner what to expect of the process. The process will collect and clarify the concerns of the community, form a platform where solutions can be debated and ensure that all parties are informed on how their expectations will be met.

The consultation process for the reserve has already been initiated in various ways:

- During casual conversations between the project officer and neighbours, site users and passers-by during various tasks in the field.
- During discussions with local leisure operators and hospitality businesses which are invested in the improvement of the natural environment of the area.
- In meetings with stakeholders and land owners to discuss management options and feasibility of the goals and aims.
- In meetings with Parish officials and Government politicians to potentiate the involvement of the general public on this project

There is scope to increase the involvement of the local community in the project as well as the general awareness on the problems facing Jerseys' puffins and other seabirds, and on the solutions that are feasible for the Island. Besides the consultation, two additional lines of work are addressing these matters at present: An awareness strategy and a community engagement plan.

The awareness strategy plans to increase public knowledge of the state of Jersey's puffins and the threats they face, as well as aims and objectives of this project. It will work on various communication fronts such as:

- Press releases and articles on local media, newspapers, websites and magazines.
- Updates and links to partners and other relevant projects on social media outlets.
- Public talks at schools and colleges, parishes, local cafes and other community centres.

The community engagement plan consists of:

- Public activities which will offer the participation of the different sectors of the community, such as children and parents, during public and online events.
- Provide the opportunity for local students to participate in an ambassadors' program to take part in various aspects of the ecological work and to represent the project in their schools and communities.
- Learning opportunities for students of institutions such as JICAS, and internships in the field of ecological monitoring and management for local students of STEM disciplines.
- Training and volunteering opportunities for the general public in a variety of research, management and outreach work of the project.

The project will also benefit the Island's society by promoting local economy and cultural values. The project will directly employ the services of local companies, contractors, suppliers and professionals, and some parts of the project will be undertaken in liaison with apprenticeship programs, education institutions and back to work schemes, in order to offer training in new skills to the local workforce. It is also believed that an increase of biodiversity and species richness in the area will promote the value of the site as a tourism asset, creating new opportunities for local travel agencies, outdoor leisure operators, hospitality businesses and small commerce. The project officer has already engaged the collaboration of various local businesses such as cafes, shops, birdwatching and other leisure operators via our awareness campaigns and interpretation materials. It is believed that Islanders place in high value the puffin as a charismatic and iconic species, and have a sense of pride on its presence in Jersey. The species is also strongly tied to the cultural history of the Island; present in Islanders' daily lives with abundant depictions on local art, household items and souvenir artifacts.

Furthermore, this project intersects with various common themes that have arisen from the Government's Common Strategy Policy, such as enabling Islanders to lead active lives, promote Jersey's profile and reputation internationally, work in partnership with parishes, community groups, volunteers and key stakeholders, and to nurture a diverse and inclusive society. Various stakeholders for this project have been engaged at the early stages and have been working in different fronts to offer their input and expertise, as well as to incorporate in this process the concerns and issues encountered during the consultation. The stakeholders will play a crucial role in strengthening ties with the local community via their roles in policy, education, employment and outreach (Table 15).

It is believed that the ecological and economical benefits of this project will outweigh the negative impacts and inconveniences on the local community, and that a straight and thorough process of consultation which engages, listens and acts upon the public's concerns can result in an overall support from the community.

The importance of the community's support for the long-term viability of this project cannot be overstated. One of the most successful predator-fence projects to date is a community-led sanctuary project which managed to raise $1.9 million in order to build 8.2km of fence, to create a predator-free wildlife reserve in Taranaki, New Zealand[107]. Since the completion of the fence the Rotokare Scenic Reserve Trust has launched several habitat restoration and wildlife translocation projects as well as producing a large body of educational material and events for schools and visitors.

Image 80. Members of the Rotokare Scenic Reserve Trust maintaining the predator-proof fence that they manage.

© www.rotokare.org.nz/Gallery

Table 15. List of stakeholders identified.

Stakeholder	Representative/s	Notes
Natural Environment Department	Tim Liddiard, Senior Natural Environment Officer Willy Peggie, Director	Partner of Birds On The Edge. Landowner of two thirds of Reserve's area. Undertakes habitat management in area.
Durrell Wildlife Conservation Trust	Glyn Young, Bird Dept Director	Partner of Birds On The Edge.
The National Trust for Jersey	Charles Alluto, CEO	Partner of Birds On The Edge. Funding and employing the Project Officer.
Vinchelez Estate		Private owner of one third of Reserve's area.
Housing, Infrastructure and Environment Department	John Young, Minister Gregory Guida, Deputy Minister	Government representation of environmental interests and policies. Have expressed support for the project.
Economic Development, Tourism, Sport and Culture Department	Deputy Kirsten Morel	Supporting cultural heritage and promoting community engagement and artistic opportunities.
St Ouen Parish	Richard Buchannan, Connectable Richard Renouf, Deputy	Local authorities and management of inhabited area, community liaison and regulations. Supportive of project proposed. Offered to moderate local platform for public consultation.
Geomarine Ltd	Iain Barclay, Operations Director	Main contractor on installation works. Local expertise, employment and apprenticeship opportunities.
Wildlife Management International Limited	Biz Bell, Director	Technical consultant on overall project but primarily on fence (design, installation, maintenance) and eradication work (planning, implementation, biosecurity).
Office of the States Vet	Dr. Alistair Breed	Compliance and legislation, technical assistance and licensing of trapping and other animal management work.
Animal welfare NGOs: JSPCA, Cat Action Trust, and Jersey Hedgehog Preservation Group	Dr. Jo McAllister Jean Falk Dru Burdon	Training and technical assistance on capture and handling of target species. Ultimate depositories of feral ferrets and cats removed from the Reserve.
Jersey Coastal Park	Mike Stentiford	Reserve is within the Park boundaries, positive impact on overall aims and goals of Park designation.

Société Jersiaise and Ornithology Section	Nicky Westwood, Stuart Fell, Mick Dryden, Tony Paintin	Local expertise on terrestrial and marine habitats, natural communities, bird populations, technical assistance on best practice, habitat management and timings of work.
Conservation NGOs and groups such as JAFW, JARG, Marine Conservation, Jersey Bat Group, JCV and various sections of the Société Jersiaise.		Local expertise and technical assistance with components of the ecological work, developing broader aspects such as sustainability and environmental responsibility, assistance in planning long-term ecological monitoring, volunteer activities and other local engagement.
Fisheries and Marine Resources Jersey Government	Francis Binney, Marine scientist Paul Chambers, Marine & Coastal manager	Technical adviser on ecological monitoring and liaison with other marine organisations.
Commercial fisheries and Association of Boat Owners (Grève de Lecq)	Royston Rimmeur Avril Rimmeur	Working or visiting area by sea, with implications in biosecurity. Will commercially benefit from regulations on mooring and landing in the area. Ongoing communications and have expressed support for the aims of the project.
Outdoor and leisure operators	Jersey Seafaris Jersey Kayak Tours	Visiting the area by land or sea. Will benefit from increase in seabird colonies and habitat restoration. Participation in consultation regarding access and regulation of traffic in the area.
Visit Jersey	Amanda Burns Rebecca Collins	Major beneficiary of the project. Consultation on promoting the area and educational campaigns of proposed work and future access regulations.
Jersey Hospitality Association Local establishments	Jeremy Swetenham, Chair Emma Machon, Cafe owner Paul Mc Dermott, Cafe owner	Major beneficiaries of the project. Have expressed support for project and there is ongoing collaboration in awareness, education and community events in area.
Jersey International Centre of Advanced Studies (JICAS)	Dr Amy Hall, Director	Opportunities to collaborate on long-term ecological research and practical conservation management.
Local community		Ultimate beneficiaries of project. Employment opportunities both direct and indirect. Improved quality of life.

6.4 Political and legally acceptability

Fences are built in Jersey for a variety of reasons: to protect equipment and property, to protect habitats and humans from hazards, and to contain pets or livestock, to name a few. Some animals are legally regarded as pests, such as brown rats, and rodenticides are commonly used to eradicate them by the general public, professional pest controllers, and many sectors of the industry. Rats and feral ferrets can also be humanely killed by licenced professionals after being trapped. Other times, feral ferrets, like feral cats, are trapped and assessed for the purpose of re-homing as pets. Wild hedgehogs found in poor health are rescued and cared for local specialists, with many being released back into the wild at or near their territories.

There are many local precedents for the various works involved in this project, and no legal impediments to the installation of a predator-proof fence, nor to the removal and management of the target species based on the options described in Section 5.1.

However, there will be a need for a consultation with various bodies in the Government to understand all legal compliance requirements and processes, and a detailed list of all permits and other authorisations needed as well as a description of the application process. Typically, this would include, but not be limited to: licenses to disturb wildlife and habitats during installation works, trapping and handling, rodenticide application, use of lethal traps, protection of native species, protection of natural resources, and protection of any historic or cultural resources on the area of the reserve. It is envisaged that memorandums of understanding will be agreed between the project management and the licensed animal organisations which will take final custody of any trapped feral ferrets or cats.

The fence in particular would require written permission from the two landowners involved, which have already verbally agreed, as well as the procurement of planning permission. Other legal requirements will likely be the presentation of an environmental impact statement and the present feasibility study.

In political terms, this project will yield benefits for the Island's nature, economy and community, by supporting the following pledges of the Government's Common Strategic Policy (CSP)[108]:

1. To protect and value our environment

This project embraces environmental innovation and ambition, aiming to protect a natural environment through conservation, management and sustainable use of resources. It will enhance local biodiversity, protect the Island's natural heritage and retain the character of this particular landscape. With the puffin colony safe from predators, many seabirds and land birds in the area will potentially have a chance to recover and thrive, including razorbills, guillemots, Dartford warblers, stonechats and linnets. The land adjacent to the proposed fenced area, recently restored by the National Trust, is a preferred feeding and resting spot for wintering skylarks and other farmland birds. All of them will benefit from predator-free foraging opportunities on the other side of the fence. On ecological terms the puffin is an 'umbrella species', which means that its protection and that of its habitats will also benefit other endangered key species native to Jersey, such as the green lizard, the slow worm and the Jersey bank vole. This project is compatible with the current Planning Law, with the Jersey Biodiversity Strategy, and with the Conservation of Wildlife (Jersey) Law. Furthermore, this project will demonstrate to global partners that the Island takes its environmental responsibilities seriously, as it falls in line with international conventions that Jersey is signatory of, such as the Convention on Biological Diversity, as well as the Bonn and OSPAR Conventions[109].

Furthermore, this project aligns with the Government of Jersey in its aims to:

- Protect areas of coast to improve our stewardship of these areas;
- Improve abundance of key indicator species;
- Protect and increase biodiversity;
- Improve access to open and green space for a variety of users, with an intervention that will have benefits over generations, and not just for the short term.

2. To put children first

As part of its community engagement strategy, the project will launch events and activities aimed at children which will improve their educational opportunities and involve them in various community-based aspects of the project.

3. To improve Islanders' wellbeing and mental and physical health

The restoration of this coastal area and the increase of biodiversity that the project hopes to generate will attract people to this area, engaging visitors with the outdoors and promoting a variety of physical activities such as walking, swimming or simply bird-watching. The public recognizes and values the environment, as evidenced by the responses to the Future Jersey public consultation. Time spent in this natural space will likely contribute to the mental and the physical health of many Islanders.

4. To create a sustainable and vibrant economy and skilled local workforce for the future.

The project will directly employ the services of local companies, contractors, suppliers and professionals. Some parts of the project will be undertaken in liaison with apprenticeship programs, education institutions and back to work schemes, in order to offer training in new skills to the local workforce. An increase of biodiversity and species richness in the area will promote the value of the site as a tourism asset, creating new opportunities for local travel agencies, outdoor leisure operators, hospitality businesses and small commerce.

Whilst this project is consistent with the CSPs and other policies put in place before the Covid-19 pandemic, it is also compatible with the Government's pursue of an Island-wide 'green recovery' and new post-Covid strategic aims.

6.5 Environmental acceptability

A risk-assessment for the installation of the predator fence will be required to evaluate the potential harm of this feature to wildlife and the environment. The assessment should evaluate direct effects such as disturbance, displacement and habitat degradation, as well as indirect effects such as litter, debris and chemical spills. It should encompass all aspects related to the process of creating the fence, from early stages of transportation of materials and ground preparation, to installation works and long-term effects on its structural integrity, such as degradation, leeching and accidental breakage.

Once installed, the fence itself will create a physical barrier to stop invasive predators from accessing the seabird breeding grounds of the reserve, as well as the many coastal habitats within it. At a mesh square of 7mm, the fence will exclude the smallest threat envisaged -a brown rat at time of weaning, and anything above that in size, encompassing all the target species. The fence will have the unwelcome effect of stopping the movements of some non-target species which are too big for the mesh. It is likely that this will include a portion of the populations of field mouse, bank vole, shrews, green lizards, slow worms and possibly all the rabbits. It is believed that the overall result of the eradication of the invasive predators will be a positive effect on most non-target species by eliminating this unnatural source of predation, and that their populations might recover to higher densities close to pre-invasives time. Any potential demographic imbalances due to the lack of movement across the fence might be naturally readdressed by an increase of pressure from native predators, such as buzzards, kestrels, marsh harriers, barn owls, short-eared owls, long-eared owls, crows, ravens, and gulls of various species. A long-term monitoring and management strategy will be required to ensure that any possible demographic changes and ecological imbalances in these non-target species are recorded, and that protocols are in place should the need for management arise.

The eradication of invasives from the reserve after the fence is installed will involve trapping, handling and potentially the death of some target species, particularly of rats. Humane traps have already been used in the area to conduct surveys with regular success on some of the target species (ferrets, hedgehogs and rats) and a very low record of incidents. The only non-targets that have been caught in live traps were rabbits that had most likely wandered inside the traps. Lethal methods such as rodenticide bait and lethal traps have not been used in the area, but their use will be necessary in order to counter the ability of some rats to evade humane traps.

A non-target risk assessment will be required to evaluate the potential harm to native species from the lethal traps and from exposure to the proposed rodent bait, and to detail measures to mitigate potential effects. The effect of the rodenticide on the marine environment will also have to be considered, although it is unlikely to have any, as bait will not be distributed into, or towards, the sea, and will be kept inside bait stations. It is possible that some bait pellets might enter the sea by being dragged outside the bait stations by rodents and then rolling off or being swept off coastal cliff edges, but at such low density it is expected to be below trace amounts. The transportation, storage, broadcasting and disposal of bait and associated equipment should be covered in the operational plan as well as the non-target risk assessment (Table 16).

Mortality of native vertebrates due to non-target poisoning has been documented, but evidence shows that affected species quickly recover to pre-eradication population levels or higher. A variety of methods have been developed to mitigate those impacts, and applied research can further aid in minimizing them. In the non-target risk assessment, the benefits of long-term species protection, recovery, and habitat restoration should be considered, along with any potential negative impacts through mortality, displacement or demographic changes. Mitigation options should be listed along its potential benefits and costs. Actions to reduce the risks to non-targets might involve various methods, or combinations of methods, such as timing of eradication works, captive-holding, aversion training or antidotes. Some actions will be potentially expensive and will increase the complexity and costs of the project, therefore the potential negative impacts on the target species will have to be balanced against the costs and the biological, cultural or socio-political reasons for implementing certain mitigation techniques.

Table 16. Preliminary list of non-target species that might require mitigation actions to avoid negative impacts.

Non-target taxa	**Species***	**Potential impacts and mitigations**
Small mammals	Field mouse, bank vole, shrew spp.	Portion of the populations not able to move across the fence, potentially isolating the populations. Monitoring of population, demographic structure and genetic variability recommended. Rodents might be at risk from exposure to bait; baiting should happen during winter when small rodents are hibernating.
Large mammals	European rabbit	Population will be isolated genetically inside the reserve. Monitoring of population size and genetic variability recommended. If density increases above carrying capacity, potential measures include one-way flaps in fence to allow individuals to exit reserve, translocations or culls.
Reptiles	Green lizard, slow worm	Portion of the populations not able to move across the fence, potentially isolating the populations. Monitoring of population, demographic structure and genetic variability recommended. If genetic variability is at risk potential measures include translocating individuals from more diverse sub-populations.
Breeding birds: land birds and seabirds	European stonechat, linnet, dunnock, wren, Dartford warbler, rock pipit, swift, Eurasian kestrel, razorbill, puffin, lesser black-backed gull, herring gull, great black-backed gull, fulmar	Disturbance during breeding season, breeding habitat damaged or destroyed. Most small land birds build a different nest each year within a territory. Seasonal nests might fall on the path of the fence; however, seabirds and cliff-nesters would not be on the path of the fence. Number of annual nests on the path of the fence is believed to be small due to the presence of bracken which is not suitable for nesting for most bird species. Mitigation measures should involve scheduling the installation works outside of the bird breeding season, and the restoration of habitats, which is in itself a main goal of this project.
Birds: raptors and scavengers	Common buzzard, kestrel, marsh harrier, barn owl, short-eared owl, crow, raven, great black-backed gull	Potential secondary poisoning from scavenging target species. The formulation of the latest modern rodenticides reduces this risk greatly however mitigation measures might include regular checks for carcasses with observers and trained dogs.

* List not comprehensive. Only a selection of species which have been detected within the area of the proposed reserve are included at this stage.

6.6 Capacity

The BOTE partnership has led and coordinated the work involved in this project to present date. The habitat management of the Plémont headland and adjacent coastal cliffs is undertaken by the Government of Jersey Natural Environment team, and involves tasks such as monitoring vegetation, removing bracken and opening clearings from encroached vegetation. The Lands Team of the National Trust for Jersey maintains and manages the restored land directly above the headland, reducing the cover of dominant species and encouraging a mosaic of coastal habitats. In 2017 Durrell Wildlife Conservation Trust funded the visit of a specialist that carried out a preliminary study of invasive predators in the study area, and in 2018 the NTJ commissioned a local consultant to monitor the puffins and other seabirds within the proposed reserved.

The National Trust for Jersey employs the full-time project officer, who has carried out most of the recent fieldwork, ecological surveys, fundraising and public communications, and who has initiated the consultation process. Managers at all three organisations have provided expert advice and steering on the various tasks accomplished, and teams of rangers from NE and the NTJ have assisted the project officer in particular tasks were many hands were required, such as clearing bracken and installing the puffin nest boxes underground.

The BOTE project officer will be responsible for the Seabird Reserve's operational plan as well as various risk assessments, biosecurity strategy, community engagement, awareness campaigns and any additional fundraising required. The officer is also likely to undertake management duties during the fence installation process, ecological monitoring and invasive predator eradication works.

A local contractor has been approached to carry out the fence installation works, and the project has outsourced an international predator-proof and eradication specialist consultancy, to assist with the technical aspects of the project such as feasibility assessments, fence design, and biosecurity plans. The project will also benefit from the experience of a similar project in the Azores Islands, as its management staff has been invited to visit Jersey and share their insights. A local consultant will carry out an environmental impact audit, whilst specific aspects of the wildlife assessment will be carried out in coordination with local experts and organisations.

If the option of using a herd of herbivores to undertake conservation grazing is explored, the landowners will negotiate a lease agreement with a local shepherd and all the administrative and practical responsibilities related to the grazing herd will be taken on by the shepherd or its representative.

The project officer is the only full-time member of staff dedicated to the seabird reserve project, but the BOTE partners' technical, practical and legal expertise is available to the project officer at all times. It is expected that specific manual works, as well as ongoing and long-term habitat works, will be led by the NE team and carried out in collaboration with the project officer and the rangers of the NTJ Lands Team, in continuation of the long-established collaboration between these organisations.

6.7 Affordability

A preliminary estimate of the cost of the project, comprising the installation of the fence and removal of invasive predators, is 879,921 GBP. This is a conservative estimate based on quotes sourced to contractors as well as projects of similar scale, which includes a 20% contingency to cover all unexpected costs and variations in matters such as fence route, eradication methods and mitigation actions. The cost for a predator-proof fence can vary a lot depending on many factors, but the usual estimates lies between 200-400 GBP per metre – it is estimated that the proposed fence would work out at 220-250 GBP/m.

The following itemised estimate covers the installation of the fence and removal of invasive predators which will effectively create the Plémont Seabird Reserve. The cost of ongoing ecological monitoring and long-term biosecurity measures will be determined at the completion of the biosecurity plan. Funding has been secured for some parts of the project or portions of them, however the bulk of the work is still to be fundraised for.

Table 17. Indicative costs for the fence installation and eradication works (in GBP)

Planning and Bye-laws	76.55
Fence design	13,500
Fence installation	650,000
Eradication of target species	2,600
Consultant fees	4,000
Nest boxes for puffins, Manx shearwaters and storm petrels	2,000
Ecological monitoring equipment and analysis software	3,500
Visit and training from Azores project representatives	3,700
Puffin decoys	2,100
Project management	31,791
QS Quantity Surveyor	20,000
Contingency (20%)	146653.51
TOTAL	879921.06

6.8 Project contingencies

After assessing the feasibility of establishing a Seabird Reserve via the installation of a predator-exclusion fence and the eradication of invasive predators from inside it, it was determined that the following contingencies should be met prior to initiating the project:

- The project is socially acceptable to the Islands' community.
- All licences and agreements are in place for the removal and management of the target species.
- All individuals of the target species can be put at risk by the removal or eradication techniques.
- The target species can be removed at a rate exceeding their rate of increase.
- The biosecurity measures can be deployed effectively and with a long-term continuity plan.
- The environmental risk assessment suggests that the benefits will outweigh the costs.
- Sufficient funding is secured prior to initiate the construction of the fence.

7. ANALYSIS OF AVAILABLE OPTIONS: COSTS AND BENEFITS

There are three main options as how to proceed given the present status of the puffin population and other seabirds in the study area (Table 15).

7.1 'No Action' Option

If no action is taken and no new species are introduced in the study area, it is expected that whatever effect rats, ferrets, hedgehogs and cats may have on the wildlife and ecosystems will continue. Predation from rats is the most likely responsible for the decrease of puffins and razorbills, and the local extinction of guillemots, over the last century. All the four target invasive predators are likely to have caused reductions in populations of many native species and to be keeping them from increasing in numbers or expanding their ranges.

The present population levels of puffins, razorbills, other seabirds and most of the wildlife found in the study area have seemingly stabilized at very low levels. The best example of this is the puffin population, which stands at 4-6 breeding pairs, a number which has not changed much in the last ten years. This might indicate an adaptive response which sees the surviving individuals being pushed to areas out of reach of invasive predators. These sites out of reach are less suitable habitats with fewer breeding opportunities, which would explain the very small number of breeding pairs found there.

The costs of this option are very high in terms of local biodiversity. The populations of puffins and razorbills are at such low levels they are considered threatened with extinction, and could be completely extirpated by a single random environmental event, such as a storm or a disease, which might not leave enough numbers or genetic variation to survive after that. Furthermore, we do not know what other effects the invasive predators are having on terrestrial wildlife, from breeding songbirds to lizards and small mammals, or what might happen to their populations should the pressure from these predators continue.

Other costs could be the potential increase of invasive predator populations across the study site, the loss of tourism revenue if the puffins become locally extinct, and the negative reaction of the community to the inaction of conservation authorities towards protecting and restoring the natural heritage of Jersey.

The only net benefit of this option is that it has no cost involved. This option also leaves way for the research and development of new techniques for managing wildlife and invasive predators which may become available in the future, such as pathogens, immunocontraception or genetic engineering. These techniques have not been fully developed or field-tested, and may be many years away yet.

As for the relation between invasive predators and natural communities at the study area, it is possible that removing the pressure from invasive predators on some prey species, like the rabbit, might have a cascade effect upon the vegetable community if the rabbit population increases and with it the grazing pressure. However, there are natural predators of rabbits in the area, therefore it would be likely that over time their pressure and density would increase as a response to an increase in rabbit numbers. It is also likely that some intra-guild competition and even predation might be occurring between the invasive predators (such as ferrets or cats killing young rats), and that if only one species was to be removed, other invasive predators might increase. However, it is stated in this proposal that all four species need to be removed at once, hence eliminating the possibility that any of them would benefit from the removal of another.

7.2 'Sustained Control' Option

This option would involve ongoing work to control or remove the target invasive predators from the reserve area and buffer zones, effectively the whole of the study area at the very least. The methods involved would likely include a combination of lethal and non-lethal techniques, such as toxins and traps.

Whilst this option might appear to have lower costs than a fence, it is the least cost-effective option on the long term, mainly due to the need for control work at perpetuity. It requires the long-term commitment of financial resources, personnel, equipment and toxic chemicals.

The main aim of this work would be to achieve sufficiently low densities of the invasive predators to result in an increase of survival, range and population of puffins and other threatened native wildlife. These techniques do not have a 100% rate of success and their starting rate of success decreases the longer the techniques are used for.

The negative effects of the control measures on the environment and on native species would also be perpetual, and might increase in time. It is likely that the continued input of toxins in the environment over time will have a negative effect on many non-targeted native species as well as the soil and water table, eventually.

The live and kill traps used for control or removal would also present serious danger to non-target species, and are very costly to maintain, bait and check on a regular basis. It is also likely that the targeted invasive mammals will develop, over time, behavioural and physiological responses to avoid or survive the control methods, such as avoiding traps or becoming resistant to the effects of rodenticide[110]. This will mean that the return per effort of the control measures will diminish over time, and will make future eradications more difficult, longer, and more costly, environmentally and economically.

Furthermore, if control works were to be stopped or scaled down the conservation benefits would be lost, as the invasive predator populations would recover quickly through lack of control and from immigration from adjacent areas. This would mean that all the financial investment, as well as the hours, months and even years of work, as well as the negative impacts that the environment and that non-target species might have suffered, had all been wasted in a pointless exercise.

In regards to the intended beneficiaries of this control work - the puffins and other native species-, the scaling down or cease of control measures would mean not only that their populations would likely decreased back to pre-control levels, but more worryingly it would mean that individuals and breeding pairs which have colonised new areas of the reserve would be put immediately at a much higher risk from predators and would likely be the first casualties of the change of management. The result of endangering native species after having encouraged them to establish in the reserve, would make this option ethically questionable.

Maintaining some form of control and removal of invasive predators at the reserve would have some benefits over the 'Status Quo' option. Ongoing control may be sufficient for slowing the rate of decline of some species, and it can be applied in a flexible manner in response to changes in conditions, budgets, personnel etc. It might be used as a temporary measure to allow for development of new techniques or to plan and implement long-term options, and it usually costs much less than installing a fence and a full eradication – although ongoing costs will be sustained for perpetuity.

7.3 'Fence and Eradication' Option

As presented in section 6.1, this option involves installing a predator-exclusion fence and eradicating or removing all four invasive predator species found within its boundaries. A predator-exclusion fence would effectively create a so-called 'mainland island', where wildlife and habitats can be managed on the whole and more effectively. Once the island is created, or in this case the Plémont Seabird Reserve, the eradication of invasive predators from within could proceed.

Eradication is a process widely researched, trialled and perfected in many islands by conservation researchers and managers all over the world, and with such positive results that many habitats have been restored and their species recovered from the brink of extinction, or even re-colonised former ranges where they had become extinct[8,111]. This positive experience suggests that creating a mainland site by constructing and maintaining a pest-proof fence and removing all invasive mammals inside the fenced area could enhance the native species and habitats within the site. This is also supported by evidence from other pest-proof sites around the world[112,113,114].

The costs and risks of this option have been detailed in Sections 5.3 and 6.5, as well as listed in Table 18. They involve mainly the high financial costs, need for long-term biosecurity, and risks to non-target species on the short term (especially during the eradication phase).

The benefits from creating the reserve cannot be overstated. All the native wildlife within it will be safe from the predation and competition of these non-indigenous invasive predators, and will have a chance to recover, increase and expand their range. All native birds breeding in the reserve will benefit: puffins, razorbills and other seabirds; but also Dartford warblers, stonechats, linnets, meadow pipits and many others. The puffin is an 'Umbrella species', meaning that its protection will also benefit other endangered key species native to Jersey, such as the green lizard, the slow worm and the Jersey bank vole. Being a protected habitat and safe from invasive predators, the reserve can be used as a creche or reservoir of native species which are endangered elsewhere. Across the fence, the land recently restored by the National Trust is a preferred feeding and resting spot for wintering skylarks, stonechats, pied wagtails and wheatears. All of them will benefit from predator-free foraging opportunities inside the reserve.

The improvement of the habitats and the increase of biodiversity and numbers of birds and other wildlife in the reserve will increase the value of the site as a tourism asset, creating new opportunities for travel agencies, outdoor leisure operators, hospitality businesses and local commerce. The creation of the reserve in Jersey is likely to raise the profile of the Island and attract visitors, generating opportunities to showcase Jersey's native species, conservation programmes and the use of new management technologies to visitors and the local community alike.

By engaging local visitors with the outdoors and promoting a variety of physical activities in the area, the reserve will contribute to the mental and physical well-being of the many Islanders. The project would also launch events and activities aimed at children which will improve their educational opportunities and involve them in various community-based aspects of the project. In the future, the local community might become even more involved in the management of the reserve. Many of the pest-proof fenced mainland islands around the world are being developed and managed by community groups, due to the popularity of these projects[115,116].

Finally, the installation of the fence and eradication work will generate employment of local professionals, and will also offer apprenticeships and training programmes via their contractors. It will also establish working links with local educational institutions, such as Highlands College and the

Jersey International Centre of Advanced Studies, to offer research and internship opportunities to students in STEM and the fields of ecological research, management and conservation.

The Reserve itself will become a case study and management tool as it develops, generating local knowledge which can be transferred to future conservation projects in Jersey and in the other Channel Islands.

Table 18. Costs and benefits of the three main management options.

OPTION	COSTS	BENEFITS
No Action	• Continued presence of invasive predators and their effects on native species • Potential extinction of native species with numbers below critical	• No economical cost • Research opportunities to monitor long-term effect of invasive predators • Gives more time for new techniques to be researched and developed to manage invasive predators
Sustained Control	• Continued presence (in low numbers) of invasive predators and their effects on native species • Ongoing financial costs of labour and materials (baiting, trapping and other methods) • Risk of alien species developing avoidance or physical resistance to control methods • Benefits will decrease over time if invasive species adapt • Will hinder future eradications if invasive species adapt or develop bait resistance • Benefits will cease if ongoing control stops and endangered populations might revert to before-control levels • Continued re-invasion from adjacent areas • Ongoing use of poison and long-term effects in ecosystem • Increase risk to non-target species being affected by control methods • Difficulty to reduce invasive predators to satisfactory levels • Cannot prevent dispersal of native species into unprotected area • Potential extinction of native species with numbers below critical	• Lower numbers of invasive predators within the reserve area • Some native species of flora and fauna will benefit to some degree, might increase breeding success and expand populations • Research opportunities to monitor ecological changes and adaptations to long-term control

OPTION	COSTS	BENEFITS
Fence and Eradication	• Restricting the range of some native species inside the reserve • High initial costs to install fence and to eradicate all invasive predators • Ongoing costs of fence maintenance and biosecurity measures • Refurbishment costs of fence every 25-30 years (predicted lifespan) • Might not exclude new invasive species not present in Jersey at the time of this assessment • Use of poison or other control methods during eradication phase will present a risk to non-target native species • Cost of development of structures, education and awareness services for the general public to use • Public access to area will be by fence gates	• Most cost-effective option in the long term • Permanent removal of invasive predators and immediate cease of their harmful effects on native wildlife • Barrier to target invasive predators • Enhanced survival, breeding, increase and expansion on Puffin population as well as many other native species • Potential re-colonisation of previously extinct native wildlife • Potential colonisation of other wildlife native to the English Channel and British Isles • Regeneration of vegetation and natural communities • Spill-over effect of some native species outside the fence as numbers increase • Track alongside the fence and regular maintenance serves as firebreak, protecting biodiversity inside from fire • Enhanced used of area by locals and tourists • Enhanced tourist revenue for leisure operators and service industries • Increased awareness of conservation and invasive species issues • Increase in public and political interest in project, with sense of pride in protection of natural heritage • Research opportunities to monitor habitat and population changes after eradication • Positive impact on similar projects in other Channel Islands and Britain

8. CONCLUSIONS

The proposed Plémont Seabird Reserve site is suitable for the construction of a predator-exclusion fence. The feasibility of this part of the project is moderate for the total length of the fence, but good when considering the different layout options proposed, as well as the potential flexibility of a staggered approach of fencing / eradicating by sections. All the technical requirements can be met with existing methodologies, but will require the involvement of predator fence experts in the final design and the input of local contractors. Water management, visual impact and public access points will be an important aspect of the final design.

The eradication or removal of all invasive predators recorded at the site is feasible by current technology and methodologies. The feasibility of preventing and managing re-invasions is moderate to good, depending on the robustness of the protocols implemented and the strength of the long-term commitments from the agencies involved.

The project is likely to gather enough support from the local community to enable it to succeed, however it is possible that the main concerns amongst the community revolve around the visual impact of the fence as well as the eradication methods and outcomes for the removed or excluded target animals. Community engagement during the consultation process and awareness campaigns will be paramount to ensure that the process is socially acceptable and manages the expectations of the local community adequately.

This assessment also states that the 'sustained control' option could only be considered acceptable in the very short-term. This option is more costly over time, its financial security cannot be guaranteed to perpetuity, has a cumulative negative impact on the environment and potentially on many non-target native species. It can hinder future eradications and, should the control cease or become relaxed, the impact to native species in the process of recovery would be negative in many fronts, such as the decline or extinction of the puffins, the loss of public confidence, and the ethical implications of such perceived waste of resources, funding, work and the lives of wild animals. This option would only be recommended in order to gain time whilst researching, planning and installing a predator-exclusion fence and committing to a full eradication.

The 'fence and eradication' is a high cost and high complexity option, but its potential reward is very high, and will likely result in higher, more effective conservation outcomes than the other options. The fence provides the chance to completely remove all the invasive predators from the reserve and to prevent them from re-invading, creating a safe and suitable habitat where the puffins and other endangered species can recover. The reserve created by the fence could also act as a source or nursery ground for other native species that can then disperse from the site to repopulate neighboring habitats and boost Island populations. It is likely that the reserve will become a tourist attraction, creating economic opportunities in the service and leisure industry, and it will also provide skill-building opportunities for many local professionals and students of related disciplines.

This feasibility study has found no obvious impediment or issue that would automatically preclude the successful construction of a predator-proof fence and eradication of all invasive predators from within the reserve. It also concludes that the environmental benefits will greatly outweigh the costs. In contrast to its many ecological and social benefits, this is a very expensive project, and it requires the long-term commitment of the BOTE partnership, the Jersey Government and its partner agencies. Maintenance of the fence, biosecurity measures and community engagement work will need to continue indefinitely to ensure the full benefits of this project.

It is recommended that:

1. Pending funding to create the Plémont Seabird Reserve, the consultation process continues with an education and advocacy programme to engage the local community in regards to the fence proposal. This should include the proposed design, location options, and the importance of protecting the puffins and endangered native species.

2. A socio-economic study is undertaken to assess the impacts of the predator-exclusion fence on the local industry and well-being of Jersey's community. This should also assess whether the selected site would be appropriate for certain community and tourist activities.

3. A fully-costed and detailed full-scale fence operational plan is developed by a pest-proof fencing specialist. The plan should include the input of local ecologists as well as contractors, in particular in regards to their experience on the expected longevity of different building materials.

4. A fully-costed eradication plan is developed for the target species within the fence site. This should include a comprehensive risk assessment to non-target species and habitats.

5. A fully-costed biosecurity plan is produced for the target species within the fence site. This should include a comprehensive risk assessment to non-target species and habitats.

6. A business plan is prepared covering all aspects of the project (including location, fence design, fence construction costs, eradication costs, maintenance costs, agency involvement, funding opportunities, predicted revenue and benefits to the endangered species). Options for financing the pest-proof fence project should be investigated (e.g. government funding, international grants, collaborative business partnerships).

7. Information and educational material is produced (i.e. leaflets, a presentation, a short video, posters) to educate decision-makers and other stakeholders about predator-exclusion fences, mainland islands, and the risks and benefits they provide.

8. Options for managing the site (government, conservation agencies, private business or community) are investigated, bearing in mind that the agency that constructs the fence does not necessarily have to be the same body that manages it thereafter.

9. A questionnaire survey is carried out among tourists and the tourism industry to assess the level of interest in establishing tours to the seabird reserve.

10. Ecological monitoring carries on during the planning process and the construction of the fence, and continues afterwards in the form of long-term monitoring schemes. This can be complemented or managed as part of ongoing collaborations with local research agencies and educational institutions.

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APPENDIX I. BIRDS OBSERVED OR ASSOCIATED TO THE STUDY AREA AND CONSERVATION STATUS

Common Name	Current Scientific Name	Conservation Status Jersey	Working List of Channel Island Birds	Red Data Categories (non-IUCN)	International Designations
Sparrowhawk	*Accipiter nisus*	Green	Scarce resident		
Common Sandpiper	*Actitis hypoleucos*			Amber	
Skylark	*Alauda arvensis*	Red	Scarce resident	Red	Jersey Biodiversity Action Plan
Razorbill	*Alca torda*	Red	Common migrant	Amber	Critically Endangered (France)
Mallard	*Anas platyrhynchos*	Green	Common resident	Amber	
Rock Pipit	*Anthus petrosus*	Green	Common resident		
Meadow pipit	*Anthus pratensis*	Amber	Common resident	Amber	
Swift	*Apus apus*	Amber	Common visitor	Amber	
Grey Heron	*Ardea cinerea*	Green	Common visitor		
Short-Eared Owl	*Asio flammeus*		Rare visitor	Amber	Vulnerable (France)
Long-Eared Owl	*Asio otus*	Amber	Rare breeder		
Common Buzzard	*Buteo buteo*	Amber	Rare resident		
Eurasian Linnet	*Carduelis cannabina*	Amber	Common breeder		
European Goldfinch	*Carduelis carduelis*	Green	Common resident		
Greenfinch	*Carduelis chloris*	Green	Common resident	Green	
Short-toed Treecreeper	*Certhia brachydactyla*	Amber	Common resident	Amber	
Ringed Plover	*Charadrius hiaticula*	Red	Rare resident	Red	
Marsh Harrier	*Circus aeruginosus*	Amber	Scarce resident	Amber	
Rock Dove	*Columba livia*		Common resident		Endangered (France)
Stock Pigeon	*Columba oenas*	Green	Common resident	Amber	
Woodpigeon	*Columba palumbus*		Common resident		
Northern Raven	*Corvus corax*	Amber	Rare resident		
Western Jackdaw	*Corvus monedula*	Green	Rare resident		
Carrion Crow	*Corvus corone*		Common resident		
Blue Tit	*Paridae*	Green	Common resident		
House Martin	*Delichon urbicum*	Amber	Common breeder	Amber	
Great Spotted Woodpecker	*Dendrocopos major*	Green	Common resident		
Common Reed Bunting	*Emberiza schoeniclus*		Common visitor	Amber	Priority Species (UK)
European Robin	*Erithacus rubecula*	Green	Common resident		
Peregrine Falcon	*Falco peregrinus*	Amber	Rare resident		
Common Kestrel	*Falco tinnunculus*	Amber	Common resident	Amber	
Atlantic Puffin	*Fratercula arctica*	Red	Rare migrant	Amber	Jersey Biodiversity Action Plan; Critically Endangered (France)
Chaffinch	*Fringilla coelebs*	Green	Common resident		
Brambling	*Fringilla montifringilla*	Green	Scarce visitor		
Northern Fulmar	*Fulmarus glacialis*	Green	Common resident	Amber	
Common Snipe	*Gallinago gallinago*	Amber	Common visitor	Amber	Endangered (France)
Eurasian Jay	*Garrulus glandarius*	Green	Common resident		
Oystercatcher	*Haematopus ostralegus*	Green	Common resident	Amber	
Barn Swallow	*Hirundo rustica*	Green	Common breeder	Amber	
European Storm-petrel	*Hydrobates pelagicus*	Amber	Scarce visitor	Amber	Near Threatened (France)
Herring gull	*Larus argentatus*	Amber	Common resident	Red	

Lesser Black-backed Gull	*Larus fuscus*	Green	Common resident	Amber	
Great Black-Backed Gull	*Larus marinus*	Green	Common resident	Amber	
Pied wagtail	*Motacillidae*	Amber	Common resident		
Grey Wagtail	*Motacilla cinerea*	Green	Occasional breeder	Amber	
Eurasian Curlew	*Numenius arquata*	Eed	Common visitor	Amber	Near Threatened (France)
Northern Wheatear	*Oenanthe oenanthe*	Red	Common visitor	Amber	Near Threatened (France)
Great Tit	*Parus major*	Green	Common resident		
House Sparrow	*Passer domesticus*	Amber	Common resident	Red	
European Shag	*Phalacrocorax aristotelis*	Red	Common resident	Amber	Jersey Biodiversity Action Plan
Great Cormorant	*Phalacrocorax carbo*	Red	Common resident		
Common Pheasant	*Phasianus colchicus*	Green	Abundant resident		
Common Redstart	*Phoenicurus phoenicurus*		Scarce visitor	Amber	
Common Chiffchaff	*Phylloscopus collybita*	Green	Common resident		
Willow warbler	*Phylloscopus trochilus*	Red	Common visitor	Amber	
Eurasian Magpie	*Pica pica*		Common resident		
Snow Bunting	*Plectrophenax nivalis*		Rare visitor	Amber	
Eurasian Golden Plover	*Pluvialis apricaria*	Amber	Common visitor	Amber	
Dunnock	*Prunella modularis*	Green	Common resident	Amber	Vulnerable (France)
Manx Shearwater	*Puffinus puffinus*		Common visitor	Amber	
Balearic Shearwater	*Puffinus mauretanicus*	Red	Scarce visitor	Red	Critically endangered (Global Red List) Priority species (UK) Vulnerable (France)
Red-billed Chough	*Pyrrhocorax pyrrhocorax*		Former resident	Amber	
Eurasian Bullfinch	*Pyrrhula pyrrhula*	Red	Scarce resident	Amber	
Firecrest	*Regulus ignicapillus*		Common visitor	Amber	
Goldcrest	*Regulus regulus*	Amber	Common resident		
Sand Martin	*Riparia riparia*	Amber	Common breeder	Amber	
Common Stonechat	*Saxicola torquatus*	Red	Rare resident		Jersey Biodiversity Action Plan
Woodcock	*Scolopax rusticola*	Amber	Common visitor	Amber	
Collared Dove	*Streptopelia decaocto*	Green	Common resident		
Common Starling	*Sturnus vulgaris*	Red	Common resident	Red	
Eurasian Blackcap	*Sylvia atricapilla*	Green	Common resident		
Common Whitethroat	*Sylvia communis*	Green	Common breeder	Amber	Near Threatened (France)
Dartford Warbler	*Sylvia undata*	Green	Scarce resident	Amber	Jersey Biodiversity Action Plan
Wren	*Troglodytes troglodytes*	Green	Common resident		
Redwing	*Turdus iliacus*	Green	Common visitor	Red	
Common Blackbird	*Turdus merula*	Green	Common resident		
Song thrush	*Turdus philomelos*	Amber	Common resident	Red	
Barn Owl	*Tyto alba*	Green	Scarce resident	Amber	
Guillemot	*Uria aalge*	Amber	Scarce visitor	Amber	
Northern Lapwing	*Vanellus vanellus*	Red	Common migrant	Red	

APPENDIX II. MAMMALS AND REPTILES OBSERVED OR ASSOCIATED TO THE STUDY AREA AND CONSERVATION STATUS

Common Name	Current Scientific Name	Conservation Category / Action Plans
Mammals		
Jersey Bank Vole	*Clethrionomys glareolus caesarius*	Own action plan - Jersey Biodiversity Action Plan
Lesser White-toothed Shrew	*Crocidura suaveolens*	
European Hedgehog	*Erinaceus europaeus*	Biodiversity Action Plan UK list of priority species
Red Squirrel	*Sciurus vulgaris*	Own action plan - Jersey Biodiversity Action Plan; Biodiversity Action Plan UK list of priority species
Millet's shrew	*Sorex coronatus*	Grouped plan - Jersey Biodiversity Action Plan
Mole	*Talpa europaea*	
European rabbit	*Oryctolagus cuniculus*	
Wood mouse	*Apodemus sylvaticus*	
Brown rat	*Rattus norvegicus*	
Feral ferret	*Mustela putorius furo*	
Cat (domestic or feral)	*Felis catus*	
Dog (domestic)	*Canis lupus familiaris*	
Reptiles		
Green Lizard	*Lacerta bilineata*	Own action plan - Jersey Biodiversity Action Plan
Slow-Worm	*Anguis fragilis*	Own action plan - Jersey Biodiversity Action Plan; Biodiversity Action Plan UK list of priority species
Common Wall Lizard	*Podarcis muralis*	Own action plan - Jersey Biodiversity Action Plan
Common Toad	*Bufo spinosus*	Own action plan - Jersey Biodiversity Action Plan; Biodiversity Action Plan UK list of priority species
Palmate Newt	*Lissotriton helveticus*	

APPENDIX III. OTHER SPECIES MENTIONED IN THE REPORT

Common Name	**Current Scientific Name**
Black rat	*Rattus rattus*
Pacific rat	*Rattus exulans*
Domestic pig	*Sus scrofa*
Red fox	*Vulpes vulpes*
Flying fox	*Pteropus sp.*
Bonin petrel	*Pterodroma hypoleuca*
Flightless cormorant	*Phalacrocorax harrisi*
Frigate bird	*Fregata sp.*
Pelican	*Pelecanus sp.*
Green turtle	*Chelonia mydas*