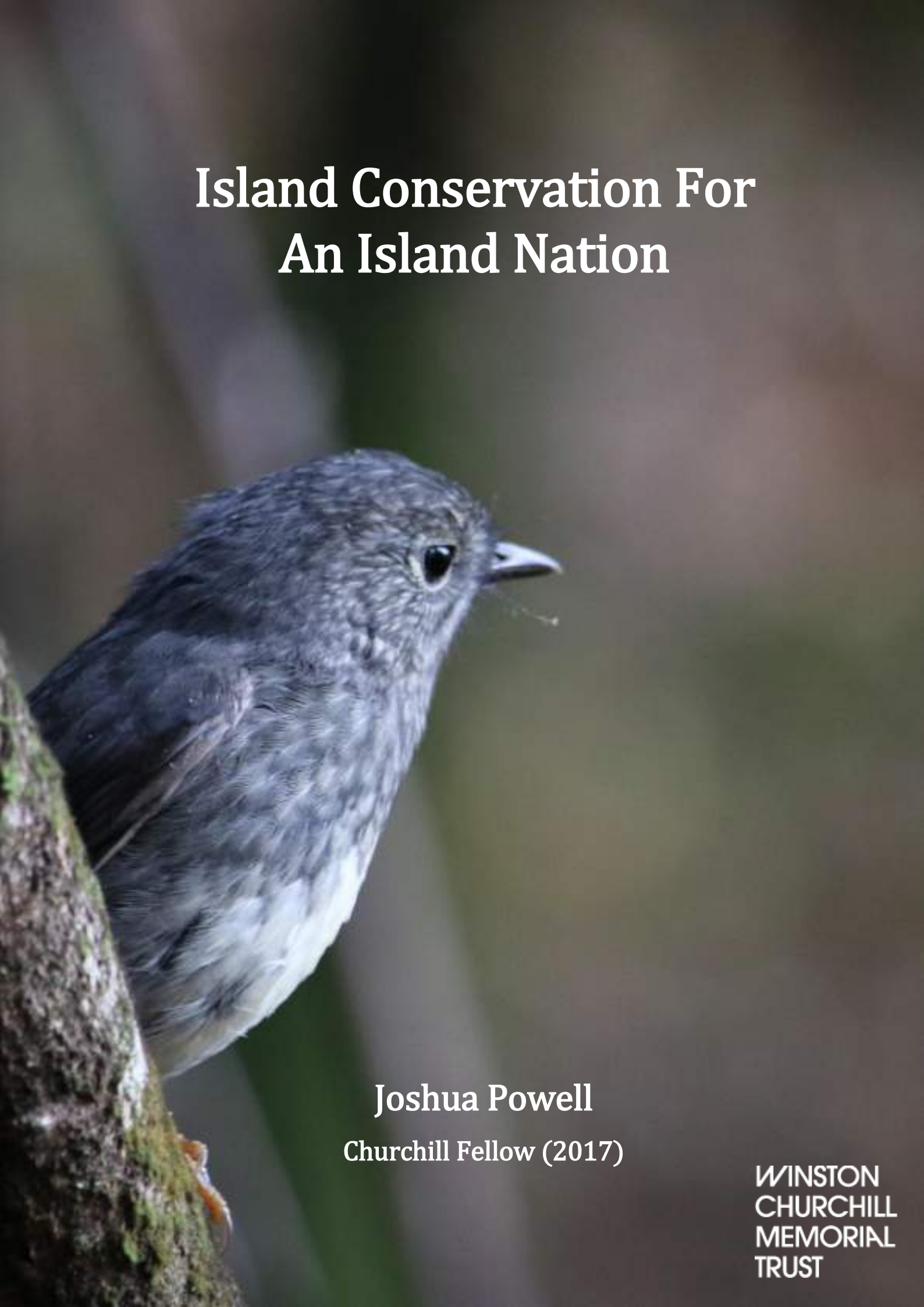
Island Conservation For An Island Nation



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WINSTON CHURCHILL MEMORIAL TRUST

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Executive Summary

With funding from the Winston Churchill Memorial Trust, Island Conservation for an Island Nation evaluated the state of island conservation in New Zealand, Australia and Fiji and what lessons from their experiences could be used for the UK's benefit.

This report is the product of a Churchill Fellowship, from April – June 2017. It is based on interviews with practitioners and policy-makers across New Zealand, Australia and Fiji, as well as their UK counterparts, and is supplemented with information supplied by their respective organisations.

For analysis, information collected is grouped by key subject areas: Models of Island Conservation, Governance, Invasive Species, Management of High Priority Species, and Innovative Approaches. Within each subject area, key actions, processes and projects are detailed, with their UK equivalents documented where appropriate. These are used to inform a number of recommendations for UK island conservation.

The key findings are:

- Practitioners should take into account geographical island type (offshore/habitat island; uninhabited/inhabited; oceanic/continental), each of which should have considerable bearing, when designing conservation strategy.
- When designing island conservation strategy the selection of suitable comparative reference examples should guide approach and may save time and resources, as well as increasing the chance of success of any intervention or policy.
- This UK's ambition and performance on island conservation lags well behind its Australasian counterparts. This report gives a number of recommendations, based on best practice in the study countries, which aim to improve public engagement in, and the effectiveness of, island conservation in the UK and British Overseas Territories. Recommendations are grouped into 6 categories:
    - Increasing Public Engagement with Island Conservation
    - Monitoring and Incorporating Innovative Techniques
    - Updating and Improving Response to Invasive Species
    - Protecting High Priority Species and Environments
    - Formalising Channels for Sharing Best Practice and Skills
    - Thinking Big: The Benefits of Ambition
- Formalising communication channels between UK practitioners and their overseas counterparts is strongly recommended to allow for the continuous and timely sharing of best practice and skills, as necessary.

Introduction

Islands are remarkable biological environments which account for a disproportionate share of global biodiversity and are home to some of the world's most threatened species. The range of islands which the UK is responsible for is truly staggering, from the metropolitan British Isles to the remote British Overseas Territories (BOTs), which incorporate everything from uninhabited Antarctic islands with vast penguin colonies, to tropical Caribbean islands with some of the world's highest levels of biodiversity by area[1].

This remarkable diversity is under threat however, as we continue to lose species. The most recent British extinction, of the St Helena olive tree (*Nesiota elliptica*), was as recent as 2003. Islands play by different ecological rules to the mainland and that means their conservation must as well; as Mel Galbraith, a Senior Lecturer in Ecology at Unitec in New Zealand, remarked, "Island Conservation and Continental Conservation require entirely different ways of thinking". As an island nation, when we look for conservation leaders to learn from, we therefore have as much to learn from New Zealand as we do from our continental European neighbours.

Island Conservation For An Island Nation looks at three countries in the Australasia region which are also at important junctures in their island conservation story: New Zealand, Fiji and Australia. In very different ways, each has shown leadership in island conservation and their experiences hold lessons which the UK can hope to draw upon. Recommendations based on these findings, intended to stimulate discussion around island conservation in the UK, are included at the end of the report, under *Conclusions and Recommendations*.

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"Islands may seem remote and insignificant, but they are home to some of the most precious wildlife on earth"

– Sir David Attenborough

The UK, An Island Nation

An island nation in every sense, the UK and its jurisdiction is made up principally of the largely continental **British Isles** and their immediate offshore islands, such as the Channel Islands, and the, largely oceanic **British Overseas Territories** (BOT, also Overseas Territories). The British Isles alone include several thousand islands, of which just the largest are permanently inhabited, while the islands of the BOTs range from sub-Antarctic islands in the South Atlantic, to tropical islands in the Caribbean. 94% of known British endemic species are found on the BOTs[2], with the island of St Helena alone containing over 500 endemic species.

The UK and the British Overseas Territories (Reproduced based on Misachi, 2017[A])

1. Introduction to Locations

i) **New Zealand**

"Offshore islands have been New Zealand's saving grace for conservation"

– Paul Kavanagh, Kiwi Birdlife Park

The world leaders in island conservation in many regards, New Zealand has a remarkable biota spread over an island landscape of staggering variety. The islands of New Zealand range from the large North Island which covers sub-tropical and temperate biomes, to the tiny subantarctic Snares Group. Widely considered to host the most diverse collection of seabirds in the world[3], New Zealand's subantarctic islands are protected as a World Heritage Area, while many of New Zealand's other islands are nature reserves, most famous of which are the trio of Little Barrier Island/Hauturu, Tiritiri Matangi Island and Codfish Island/Whenua Hou. 85% of New Zealand's third largest island (1,746km² island), Stewart Island/Rakiura, is covered by Rakiura National Park. Offshore islands, several of which have sheltered the last remaining individuals of some of New Zealand's most threatened endemic species, have formed the cornerstone of New Zealand conservation policy.

Conservation of biodiversity on New Zealand islands is the cabinet responsibility of the Minister for Conservation, who is supported by the Department for Conservation (DOC), made up of regional and local offices throughout the country and a national leadership team, led by a Director-General, based in Wellington. In 2016, Prime Minister John Key declared a target to remove all non-native predator (pest) species, subsequently confirmed as possums, rats and mustelids, from New Zealand by 2050.

The world's only alpine parrot, the kea (*Nestor notabilis*) is endemic to New Zealand's South Island

ii) **Australia**

Australia, the smallest continental land mass and historically compared to an island, has a diverse range of true offshore islands. To its south lies the island of Tasmania, an Australian state in its own right, while the smaller offshore islands of Norfolk Island, the Torres Strait Islands and the Cocos (Keeling) Islands stretch from the Pacific to the Indian Oceans. Some of the most biologically significant are protected as UNESCO World Heritage Sites, including subantarctic Macquarie Island, Fraser Island which is the world's largest sand island, Lord Howe Island in the Tasman Sea between Australia and New Zealand, and the collection of 900 islands that make up the Great Barrier Reef World Heritage Site, while Tasmania has 3 World Heritage Sites. Several islands close to the Australian mainland with notable biotas attract significant visitor numbers, including Kangaroo Island, in South Australia, and Rottnest Island, famed for its quokka (*Setonix brachyurus*) population, in Western Australia.

The Department of the Environment and Energy, a federal government department based in Canberra and answerable to the Minister for the Environment and Energy, has national responsibility for environmental protection and the conservation of biodiversity. In practice, however, island conservation is managed by individual states and their respective government bodies, for example the Tasmania Parks and Wildlife Service for the state of Tasmania. There is little co-ordination between states.

iii) **Fiji**

Popularly referred to as a collection of 333 islands, of which perhaps less than a third are inhabited, Fiji is the most populated and one of the largest of the South Pacific island states. Many of the conservation bodies with regional chapters have their headquarters in Fiji and almost all of them are headquartered on just one street in Fiji's capital, Suva: Ma'afu Street. Key bodies include WWF South Pacific, the Fiji Locally Managed Marine Area network (FLMMA) and Wildlife Conservation Society Fiji (WCS-Fiji), as well as national organisations like the National Trust of Fiji. The Department of Environment is the government agency responsible for the conservation and monitoring of biodiversity and ecosystems.

Mangrove coastline, Viti Levu island, Fiji

2. Models of Island Conservation from Australasia

The concept of an 'island' covers a wide variety of different geographical features. In the Australasia region this is reflected by several different models of island conservation, each of which present different opportunities for shared learning and collaboration with their British counterparts.

It is important to note that the following are models and cannot be applied as blueprints. Each model's success in its applied location has been a question of individual geography. Success will be determined by selecting the appropriate model for a given location, learning from the experiences of that model and designing an approach which is adapted to suit local conditions. This is particularly true where a model is reliant on the presence of certain circumstances which may not be found elsewhere (for example, a nearby population centre).

Restored Offshore Islands - The Tiritiri Matangi Model

Tiritiri Matangi Island is a world famous example of a restored offshore island. Starting with Dick Veitch's release of red-crowned parakeets/kakariki (*Cyanoramphus novaezelandiae*) in 1974 and its subsequent revegetation (1984-1994) through the efforts of a dedicated body of volunteers, the island was transformed from an agricultural landscape where 94% of the native bush had been lost or degraded, to 60% forest cover with a biota which includes some of New Zealand's rarest wildlife.

Giant Weta (*Deinacrida heteracantha*), the world's largest insect and just one of the rare species visitors come to Tiritiri Matangi to see

The transformation of Tiritiri Matangi has inspired numerous island restoration projects around the globe. The island has been a popular and effective introduction to island conservation for countless visitors and is ranked by TripAdvisor as the top-rated attraction in

New Zealand's populous Auckland region. The loss of topsoil from Tiritiri Matangi's years under agricultural production has hampered progress on the introduction of further native seabirds to the island.

Restored offshore islands have application for both the British Isles and BOTs. Candidate examples might include Brownsea Island in Dorset.

The Tiritiri Matangi Model is notable for its: restoration of a previously degraded landscape, close proximity to a large urban area, open reserve access, high emphasis on education, volunteer engagement.

Supporter Groups

Supporter groups can be seen time and again in New Zealand conservation, with over 150 groups focussed on kiwi conservation alone. Through supporter groups, remarkable numbers of New Zealanders volunteer time and expertise to conservation. Supporter groups are often involved in pest control, ecological monitoring, education and public awareness, as well as sometimes being involved in translocations. Supporter groups play an active role in island conservation, from the *Supporters of Little Barrier Island* to the *Friends of Tiritiri Matangi*. As the latter have required more specialist groups over time they have shifted to training volunteers to a specific project (i.e. species specific groups), with the aim to retain them in that group and thus reduce the need for retraining.

<u>Restored Habitat Islands – The Zealandia Model</u>

A habitat island on the New Zealand mainland, Zealandia performs many of the roles of Tiritiri Matangi, despite the fact that the reserve borders New Zealand's capital city, Wellington. The sanctuary of 225 ha, first established in 1992, is a restored valley enclosed by a predator exclusion fence and has been the recipient of numerous endemic species notable for their conservation significance through translocation programs, including little spotted kiwi (*Apteryx owenii*), brown teal (*Anas chlorotis*) and tuatara (*Sphenodon punctatus*). Paul Kavanagh, of the Kiwi Birdlife Park, credits Zealandia with a 'halo-like effect' in which its impact has expanded outwards over time, leading to increased numbers of kaka (*Nestor meridionalis*) and other native species around the city's limits.

Aerial view of Zealandia, with its remarkable proximity to the city of Wellington (Zealandia)

The reserve has become a significant tourist attraction and education tool for visitors and residents of Wellington alike. Zealandia sees itself as a global model for restoration and has already inspired numerous restoration projects in New Zealand, such as Bushy Park (98 ha). Unlike Tiritiri Matangi, which has just two paid members of staff within the *The Friends of Tiritiri Matangi* (in addition to the permanent presence of DOC Rangers on the island) and where restoration work has been conducted by volunteers, Zealandia employs a full staff and the site includes a café and gift shop. The sanctuary has, however, relied on financial support from Wellington City Council and struggled to become self-sustaining.

The composition of the British Isles' native biota would present challenges to a Zealandia model being implemented on the borders of London, however there is potential for restored habitat islands in the UK. Existing examples of such an ambitious agenda are, to date, limited, the most famous being the Alladale Wilderness Reserve in the Scottish Highlands.

The Zealanida Model is notable for its: close proximity to a large urban area, habitat island characteristic, open reserve access, high emphasis on education, commercial operation.

Large Islands with Native Mammal Populations - The Tasmania Model

Tasmania differs quite significantly from the other sample locations in two regards. First, it has a native, and endangered, endemic mammal population, while in many of the other locations in this study all mammals are considered 'pest species'. Second, like New Zealand's North Island (113,729 km^2) and South Island (151,215 km^2) islands, Tasmania, at 68,401 km^2, is considerably larger than many of the other islands featured (by comparison Ireland covers an area of 84,421 km^2), making it directly relatable to the British Isles.

Terrestrial conservation strategy for large islands with native mammal populations often draws more closely on continental conservation strategy than that on other island systems do. Unable to designate the entire island, Tasmania utilises a network approach of protected areas, including 3 World Heritage Areas covering 1.58 million hectares, 19 national parks and over 800 reserves.

Eradication programs for invasive species must be specific in such circumstances, due to the presence of both native (and sometimes endangered) mammal species and domestic animals. Human-wildlife conflict is often a challenge to the conservation of native mammal species because of the impact it can have on societal perceptions of the species, making stakeholder engagement crucial; in Tasmania, Tasmanian devils (*Sarcophilus harrisii*) sometimes take lambs and will harass ewes. Recognising the impact on livestock and human property is essential to ensuring the success of stakeholder engagement, such that all parties feel engaged and their concerns considered. Roadkill deaths constitute a threat to many ground-dwelling native species on large inhabited islands, including to Tasmanian devils on Tasmania.

The Tasmania Model is notable for its: landscape level approach, stakeholder engagement, native mammal presence, large island scale.

Multi-Island Conservation - The Seascape Model

Fiji's seascape model represents a landscape level, multi-island conservation model. It serves as an effective model for island conservation where the individual points (islands) are small but numerous and make up only a fraction of the overall matrix (ocean) coverage. By taking a landscape level approach, the seascape model allows for balancing both reserve areas and areas permitting the sustainable harvesting of terrestrial or marine wild products, within the same seascape. This model is therefore ideally suited to many of the Pacific Island countries, being made up of vast numbers of small islands, where social conservation must be balanced alongside the needs of local livelihoods. Conservation International, WWF South Pacific and WCS Fiji, all operate seascape projects in Fiji. Key to the seascape model is developing sustainable financing mechanisms to support conservation and building capacity, in co-operation with local communities and to ensure wise governance.

The Seascape Model is notable for its: landscape level approach, multi-island scale, social conservation, stakeholder engagement, building capacity, combined point/matrix approach.

Restricted Access Offshore Islands - The Codfish/ Whenua Hou Model

Offshore islands which have restricted access for conservation purposes, as opposed to due to private ownership or military use, are often designated on the basis of being considered among a nation's most biologically significant. Such islands may serve as a reserve population for particularly rare species, or contain the entire global population of a Critically Endangered species; for example, the global range of the Kakapo (*Strigops habroptila*) is made up of three restricted access offshore islands, including Codfish Island/ Whenua Hou.

Little Barrier Island – An Underexplored Island

Remote, access highly restricted, and noted for its steep, difficult terrain, Little Barrier Island/Hauturu remains largely un-surveyed, despite being New Zealand's oldest nature reserve (1895). The restricted access offshore island model here proves an obstacle to further survey work as scientists are discouraged from staying overnight, meaning that in practice many areas of the island remain unreachable. Movement on the island, even by the permanently stationed DOC ranger, is largely restricted to use of the few tracks that cross the island. A large amount of aquatic systems on the island have not been surveyed and there has been no work to survey the forest canopy at all.

Restrictions to human access are justified on the grounds of reducing the risk of biological invasion, accidental disturbance or poaching of highly endangered species, as well as moral arguments about 'leaving some space for nature' (Wade, pers. com., 3rd May 2017). Such an approach may also simplify management of high priority species, as this allows for implementation without the need to also manage human visitors. On some offshore islands access may be restricted due to specific ecological reasons, for example, visitors are not allowed to land on the Snares Group/Tini Heke in New Zealand because of the abundance of muttonbird/titi (*Puffinus griseus*) ground burrows. Most restricted access offshore islands also have restricted access due to geographical factors, being either very remote or inhospitable, which may have historically limited human impact. In contrast to offshore

islands which are open reserves, such as New Zealand's Ulva Island, restricted access offshore reserves either have heavily permitted access (such as Macquarie Island, Australia), or no access at all except for scientific researchers (Codfish Island/Whenua Hou).

New Zealand in particular has a high prevalence of restricted access offshore islands, a policy which is not without its critics. One of the charges levelled against restricted access islands was that the policy was elitist: scientists and prominent visitors could visit the island because of their status, but the general public or tourists could not, despite a lack of published evidence for even a single biological invasion caused by tourist visitation in the presence of properly implemented biosecurity measures (Russ, pers. comm., 14th April 2017).

The Codfish/Whenua Hou Model is notable for its: high national priority, endangered species, restricted access (heavily permitted - scientific research only), geographical isolation, predator-free status.

Island Conservation and Tourism

Biodiversity conservation on islands is of economic significance because it maintains an often rare biota that attracts wildlife tourism. Tourism makes a valuable contribution to local economies and in many cases, such as on New Zealand's Stewart Island/Rakiura, makes up a significant percentage of the island's economy. In turn, the economic incentive of tourism revenue encourages further conservation efforts.

Tourism also presents challenges for conservation and must be managed appropriately. Approaches to minimising the impact of tourism include the introduction of raised walkways and viewing platforms to protect fragile island vegetation, as has been installed for Australia's Macquarie Island, the presence of wildlife rangers attached to tour groups, as has been implemented in New Zealand and for Macquarie Island, biosecurity training sessions for tour operator staff, a tax on visitors which can be used to support conservation programs for the islands visited, a direct visitor cap, or, in the case of a restricted access approach to high-priority islands, limiting visitation to only certain islands.

Tourists are not permitted to land on the majority of the New Zealand subantarctics, with the exception of Campbell Island/Motu Ihupuku and the islands of Auckland Island and Enderby Island in the Auckland Islands group, where visitors are subject to strict biosecurity procedures. Such an approach has proven unpopular among some tourism operators who point to a lack of published data on the link between tourism visitation and biological invasion, the success of raised platforms for visitors in preventing damage to vegetation on islands where they have been installed, and examples of biological invasion being caused by the mistakes of scientists, rather than tourists. Although both parties have broadly similar goals in their desire to promote the conservation of New Zealand's islands, the division threatens the relationship between tourism operators and the regulatory authority, DOC, which is to the detriment of their ability to provide mutually beneficial partnerships.

Case Study: Subantarctic Islands

Subantarctic islands, and the Antarctic islands further south, tend to be managed worldwide as restricted access offshore islands. New Zealand's subantarctic islands, designated a World Heritage Site on the basis of floristic diversity, are made up of 5 separate island groups located between 47 and 52 degrees latitude south: the Snares /Tini Heke, Auckland Islands/Motu Maha and Campbell Island/Motu Ihupuku to the south of South Island, and the Bounty and Antipodes Islands to its south-east. Between the 5 groups, there are 19 floral species endemic to just a single island group, with a further 28 species endemic to the New Zealand subantarctics as a whole[4]. The islands provide breeding sites for 11% of the world's known seabird species[5]. Another World Heritage Site, Macquarie Island, is their Australian counterpart, lying at 54 degrees latitude south. The UK's subantarctic and Antarctic islands are found on the Atlantic side of the Southern Ocean, including South Georgia and the South Sandwich Islands, the Falkland Islands and the South Shetland Islands.

The benefits of the transboundary sharing of best practice and expertise is well understood in the subantarctic region, for each subantarctic island tends to be more similar to the next than it is to their mainland environment. For example, the UK subantarctics are more similar to the New Zealand subantarctics than they are to the British Isles. The level of collaboration between New Zealand's DOC and the Tasmania Parks and Wildlife Service has been particularly high: Tasmania Parks and Wildlife Service representatives can fill requirements for tourist ships to the New Zealand subantarctics to have a DOC-approved ranger on board, while DOC employees have in the past visited Tasmania to look at biosecurity measures and Noel Charmichael, Macquarie Island Executive Officer at the Tasmania Parks and Wildlife Service, praised the expertise of the New Zealand personnel who advised the Macquarie Island pest eradication (2006-2014, operational phase 2011-2014).

Geographical isolation means a low public profile and it is unlikely that a high percentage of the public are aware of the ecological significance of the subantarctics, or the significant role that organisations such as the Royal Society for the Protection of Birds (RSPB) play in their conservation on the BOTs. Public awareness regarding the subantarctics appears to be better in both Australia and New Zealand, perhaps due to the range of publications covering them and the media attention given to their large eradication programs. Rodent eradication programs on the UK's South Georgia (2011-2015) have made national news, but have not yet been afforded the same prominence, despite the fact they were larger in magnitude that any comparable eradication program to date[6].

Megaherb field, Campbell Island (Department of Conservation)

3. Governance

One of the fundamental differences between the practice of island conservation in the UK, compared to New Zealand, Australia, or Fiji, is who takes the lead on island conservation projects, a difference which is largely determined by a variation in governance.

The UK has no equivalent body to New Zealand's DOC, which operates on a national level with regional offices. Although the Department for Environment, Food & Rural Affairs (Defra) is the government department responsible for conservation decision-making, they are supported by a range of different devolved agencies in Natural England, Scottish Natural Heritage, Natural Resources Wales and the Northern Ireland Environment Agency. The disadvantage of this arrangement is that performance can vary between regions, as is also the case for Australia which works through devolved, state-level bodies. In the Australian case, Tasmania and Western Australia perform better on island conservation than their counterparts, with New South Wales also having taken some positive steps. This situation is compounded by the fact there is little co-ordination between Australian states, with little appetite for it. Keith Springer, one of the most experienced figures in island conservation programs worldwide, recounted suggesting the value of establishing a national body for Australia to provide coordinated advice, planning and equipment at a workshop in Canberra and noted that: "not one state representative saw any merit in that idea".

To an even great degree of devolution is the BOTs. The BOTs hold the greatest concentration of rare and endemic species of anywhere under the UK's jurisdiction, but Westminster plays little active role in their conservation, the BOTs being highly devolved and largely overseeing their own affairs. The exception is the British Indian Ocean Territory (BIOT), which remains under international scrutiny. In its place, managers for the respective BOT governments have responsibility for island conservation in their jurisdiction, but often have limited personnel and resources available. This has meant that a range of charities, notably the RSPB, through their Overseas Territories Unit, as well as smaller charities such as the South Georgia Heritage Trust, have come to play important roles, an arrangement which bears some comparison with Fiji, where civil society and nongovernmental organisations play key roles in island conservation.

Department of Conservation (DOC)

Since its formation DOC has been at the forefront of conservation efforts in New Zealand and is an example of an effective, centralised conservation department. The presence of an entire government department dedicated to conservation provides a natural leading body on conservation efforts in New Zealand. There is no comparable body in the UK.

The fundamental difference with the UK, therefore, is that while in New Zealand it is DOC, as a government department, who lead island conservation throughout New Zealand's exclusive economic zone (EEZ), in the UK-context, throughout a significant portion of the country's EEZ (specifically that covered by the BOTs) it is charities who do so.

The scale and ambition of DOC's program for island conservation can be seen in the Predator-Free New Zealand 2050 target, but DOC has not been without its faults.

Commercial tourism operators interviewed noted that while they were willing to provide resources and assistance to conservation programs, DOC were cautious of private enterprise's involvement, despite the department's newly mandated strategic partnerships agenda. DOC has shown evidence of improving in areas where it was traditionally weak, for instance an increasing number of DOC employees now spend time overseas to gain experience working with different management systems, before bringing that knowledge back to New Zealand.

"When it comes to the rehabilitation and the management of islands for conservation DOC is the TOPs. In my opinion they lead the world"

– David Bellamy OBE

Community Conservation

As well as supporter groups (see *Supporter Groups*), which are often embedded in the local community, community conservation has several notable regional facets. Some of the most important are:

a) **The Locally Managed Marine Area Network**

The Locally Managed Marine Area Network (LMMA) serves as the principal international network for marine conservation and resource management for the Pacific region, with national bodies for most countries in the region. The LMMA Network embeds the principles of sharing best practice and network learning into its approach, by providing the opportunity for discussion, communication and coordination between countries.

Community resource owners form the heart of the LMMA Network. In Fiji and its partner Pacific Island Nations, the communities themselves are the resource owners, an increasingly unusual phenomenon on a global scale. The LMMA Network prioritises empowering these communities, while drawing on technical expertise of resource conservation NGOs, academic institutions and government. In Fiji, LMMA's national body, the Fiji Locally Managed Marine Area (FLMMA) network, works with over 400 communities in order to promote the preservation and sustainable use of marine resources.

Independent, but supported by FLMMA, is the Women in Fisheries Network – Fiji (WiFN-Fiji), which is concerned with the gendered dimensions of fisheries. A significant focus of the work of WiFN-Fiji is on subsistence fisheries, such as the mud crab fishery, which make important contributions for the personal economy of many local women.

The BOT of the Pitcairn Islands, like French Polynesia, is not part of the LMMA network. With the Pitcairn Island Council, the Pew Environmental Group and National Geographic campaigning for the entire EEZ of the territory to be designated a marine protected area, this report recommends for Pitcairn to become a member of LMMA, which would formalise the provision of support from the network for the territory.

b) **Iwi and conservation-heritage links**

In New Zealand one of the most promising developments for community conservation is the increasing involvement of Iwi (Maori communities) in conservation. Social responsibility and conservation do not always go hand-in-hand, but New Zealand has found a way to strike a both pragmatic and effective course. For example, while local Iwi wanted the return of Codfish Island/Whenua Hou, one of the most important nature reserves in the country, and the New Zealand government wanted the island to remain a nature reserve, a solution was found in which the island would remain a reserve and a partnership would be formed through the Whenua Hou Committee, which would include both Iwi and DOC Southland representatives. With these links predicted to increase they represent a promising trend based around Kaitiaki, a Maori concept which refers to guardianship of the land, sea and sky.

c) **Public engagement with island conservation**

New Zealand makes the case for public engagement in island conservation. Public support can result in financial backing for specific programs (for example, DOC recognises that the 2016 Antipodes Island mouse eradication would not have been possible without donations by the New Zealand public and private foundations), direct support for island conservation objectives (for example, DOC's War on Weeds has volunteers actively remove weed species that threaten ecological change on North Island and South Island) and can translate into political support.

The Great Britain Invasive Non-Native Species Strategy (2015), published by Defra[7], acknowledges that public awareness of the impact of invasive species for the UK and BOTs remains poor both among the public and among government departments. By contrast, New Zealand has had considerable success in building grass-roots conservation support through sustained efforts by government, non-profits and the leadership of ground-breaking individuals. New Zealand's Predator-Free 2050 target has brought the issue further to the public's attention, attracting extensive media coverage. The New Zealand public appear both informed and engaged on the issue, largely thanks to education campaigns and such high profile coverage. There is no reason such an approach would be out of place in the UK.

This report would like to note the importance of engaging young British conservationists on island conservation. Doing so is challenging because the BOTs in particular remain remote concepts for most in the UK and they are rarely covered in secondary or tertiary education. Young scientists, through dissertation studies and fieldwork, represent untapped potential to help collect information on biodiversity on the BOTs, a lack of which has historically impeded conservation efforts[8].

The RSPB's free outreach visits for schools, supported by Aldi, are an excellent way to connect young people with nature, but their coverage is limited to certain cities across the UK, only cover material up to primary school level (Key Stages 1 and 2) and are reliant on the individual school making contact with the RSPB's education team. Developing an Island Conservation session would be a worthwhile addition to those currently offered. While

secondary school (Key Stages 3-5) talks are more challenging than primary, New Zealand has shown they can be a success. New Zealand successfully holds conservation talks and workshops for school children all the way through compulsory education; again there is no reason why the UK cannot do likewise.

The school lecture series *Island Conservation For An Island Nation*, developed as part of this project, will directly introduce island conservation in the UK to school groups and test whether the content material is suitable for both primary and secondary schools. There is also a role for government; collaboration between Defra and the Department for Education, to include the BOTs in the secondary curriculum, would introduce the UK's overseas territories and the conservation challenges they face to students across the country.

International Collaboration

The foremost advisory group on island eradication programs in the world, New Zealand's Island Eradication Advisory Group (IEAG) have become a pan-global advisory body, providing advice to eradication programs on a wide range of BOTs, such as South Georgia, Gough Island and Henderson Island, among others, while nominating technical advisors and providing advice for a wide range of other eradications. Individual New Zealand specialists have also served as operational or technical advisers for eradication programs worldwide, for example Keith Springer serves as a Gough Island Restoration Operational Advisor for the RSPB, while Pete McClelland has performed a similar role in Alaska and British Columbia, and Nick Torr and Derek Brown have both been involved in programs on South Georgia, Gough Island and Henderson Island. Springer believes New Zealand's pre-eminence in island eradication expertise can be traced back to a pressing need for eradication programs to be implemented in New Zealand to relieve pressure on endemic bird species, coinciding with developments in GPS technology, as well as the presence in New Zealand of both offshore islands in Crown ownership and the ready availability of helicopters and pilots with agricultural experience. Having developed the crucial combination of skills and expertise, New Zealand has begun to export eradication expertise and products.

Across the Pacific region, Fiji plays a significant role in regional co-ordination as many of the international; conservation non-governmental organisations with regional bodies, such as WWF or Conservation International, have these based in Fiji. The Pacific Invasives Initiative, based in Auckland, New Zealand, is also involved in providing co-ordination for the Pacific region, but specifically regarding invasive species.

Island Conservation, a US-based non-profit, play an important role in island restoration projects across the Pacific, Caribbean, North and South America. Island Conservation currently does not have staff in Europe, Asia or Africa, where the presence of native mammals presents a very different challenge for island restoration programs.

4. Invasive Species

Invasive species, identified as the second greatest threat to global biodiversity[9] [10], present a heightened threat to island systems. For example, novel predators can present an existential threat to island species without traditional defensive mechanisms associated with their genus, the fate of many of New Zealand's endemic species, including the New Zealand quail (*Coturnix novaezelandiae*), which went extinct in 1875, the bush wren (*Xenicus longipes*), extinct in 1972, and the greater short-tailed bat (*Mystacina robusta*), of which there have been no sightings since 1965 and is suspected extinct. The impact of invasive species is considered of political and economic importance for the UK[11] and strategy is governed by The Great Britain Invasive Non-Native Species Strategy (2015). For the South Atlantic BOTs, where climate change potentially presents novel biological invasion challenges for the region[12], it is the RSPB that published the South Atlantic Invasive Species Strategy and Action Plan (2010), with signatories from each of the South Atlantic BOT governments.

Invasive species strategy on island systems tends to have two central tenants: biosecurity measures to prevent further invasive species reaching island systems and eradication programs to remove invasive species already there. By the start of the 21st Century, New Zealand had begun to excel in both regards.

Biosecurity

New Zealand has one of the most advanced biosecurity programs of any country. While biosecurity remains a national priority, particular emphasis has been placed on the World Heritage subantarctic island groups and other offshore predator-free islands.

In the New Zealand subantarctics, DOC have introduced hull checks for boats and have begun to consider the biosecurity implications of fishing vessels, although such moves have met with some industry resistance (Trainor, pers. com., 28th April 2017). Tour operators to the New Zealand subantarctics are faced with some of the strictest biosecurity measures in place anywhere in the polar and sub-polar regions. As part of the permit issued to tour operators they are required to cover the cost of DOC representatives aboard every vessel and to conduct biowashes every time passengers disembark.

For larger regions it may be appropriate to have internal biosecurity measures, as applied in Australia, which operates biosecurity on a state-by-state basis through the Australian Interstate Quarantine program.

For example, when travelling to New South Wales and the Australian Capital Territory bulbs are prohibited for

Biosecurity signage, Ulva Island, New Zealand

transport if you are travelling from Victoria or Western Australia, but are permitted if you are travelling from any other Australian state. Unlikely to be necessary for the UK itself, except in exceptional circumstances, this approach mirrors that for the South Atlantic BOTs where one BOT is responsible for different island groups (for example, biosecurity measures apply between South Georgia and the South Sandwich Islands, which form a single BOT).

Invasive Species Response

New Zealand has led the global charge on invasive species on island systems. With now world famous examples of uninhabited islands where invasive animal species have been eradicated, such as Tiritiri Matangi Island, New Zealand has become a model for eradication programs worldwide. Two opportunities now present themselves to DOC. The first is to export expertise worldwide to assist in eradication programs in other countries. The second is to shift focus towards the more challenging prospect of eradication programs on inhabited islands, as addressed by the recently announced 2050 Predator-Free New Zealand target.

Despite the success of New Zealand's pest eradication program, it was initially met with significant opposition. Only now has growing acceptance of the program in New Zealand become more widespread, although some international commentators remain critical[13] and certain dimensions, such as the extermination of feral cats, remain out of public sight. 1080 is the most widely used toxin in New Zealand mainland animal control programs and the public controversy surrounding use of the toxin on such a wide scale will be known to anyone familiar with conservation in New Zealand. While the question of bioaccumulation in birds of prey remains pertinent, all practitioners interviewed agreed that 1080 remained the most effective tool available in animal control programs. Brodifacoum is the most widely used toxin in New Zeland for island pest eradications, primarily targeting rodents.

Public opinion on New Zealand's pest eradication program and the use of 1080 has improved because DOC has highlighted the tremendous number of endemic species that have gone extinct in New Zealand due to the impact of invasive species. The clear correlation between certain invasive species and specific extinctions has overwhelmingly made the case that eradication programs, though expensive and sometimes unpalatable, at times may be essential to preserving national and global biodiversity.

The same arguments have not been well articulated in the UK. Eradication programs are so important for New Zealand because it is made up of remote oceanic islands, with high rates of endemism among the native biota and an ecological composition which makes the ecosystem highly vulnerable to biological invasion. Many of the arguments against eradication programs are based on the case of continental islands, an important biogeographical distinction. On the British Isles, as continental islands with a high percentage of introduced species, many of those arguments are relevant, but for the BOTs, which, like New Zealand, tend to be remote oceanic islands, eradication programs will be important tools in preventing the extinction of endemics. In order to secure public support for eradication programs those arguments need to be articulated with the same eloquence and determination that they have in New Zealand.

The removal of certain invasive species is challenging because of their sport characteristic. Anglers in New Zealand would object to the removal of trout (*Salmo trutta* and

Oncorhynchus mykiss), as the hunting community opposes the removal of deer (7 species). This presents challenges for conservation. In Tasmania the Inland Fisheries Service considers trout a threat to the state's native fish, which include 12 threatened species (rare, vulnerable, or endangered). The Inland Fisheries Service has therefore been restricted to issuing guidance to not move introduced species, including trout, between water bodies.

Eradication Programs on Uninhabited Islands

As New Zealand has become the global leader on invasive species eradication programs, considerable expertise has been developed. The sharing of information and expertise has become common and New Zealand practitioners were involved in the multi-species eradication on Macquarie Island in Australia, declared successful in 2014, which also benefited from advice from DOC's IEAG. New Zealand practitioners have been involved in working on or advising eradication programs around the world, including those on the BOTs of South Georgia (South Georgia and the South Sandwich Islands), Gough Island (Tristan da Cunha), Henderson Island (Pitcairn Islands), the British Indian Ocean Territory, as well as invasive programs across the Caribbean BOTs. Such advice and experience can prove invaluable, as eradication programs are challenging, costly affairs.

Million Dollar Mouse: The Logistical Challenges of a Subantarctic Eradication

Million Dollar Mouse, the 2016 mouse eradication program for the Antipodes Islands, which was jointly funded by DOC, WWF-New Zealand, Island Conservation, the Morgan Foundation and contributions from the New Zealand public, is an excellent case study of a government-civil society partnership at the heart of an island conservation initiative. The eradication program was logistically complex as the Antipodes have limited infrastructure, no harbour to shelter the 2 ships required (1 supply, 1 passenger) for the eradication program, challenging weather conditions, with the eradication program needing to be conducted during the subantarctic winter, and a remote geographical location (760km south-east of the New Zealand mainland). At a budget of NZ$3.9m (£2.1m), there was little room for failure. Monitoring in 2018 will be used to determine whether the program was a success.

Even following best practice there is a chance that eradication programs may fail. The UK's mixed record of success with eradication programs on uninhabited islands includes the failure of the Henderson Island rat eradication program in 2011, which surprised many in the industry. The program's failure was expensive, as it would require a second attempt, and rat numbers rapidly recovered[14]. Despite providing a temporary reprieve for the endangered Henderson petrel (*Pterodroma atrata*) and other seabirds threatened by the invasive rat population, this outcome was highly disappointing. One suggestion is that the program was hampered by unseasonal rainfall before the program dates, which caused an increase in natural food sources available before the baiting program and therefore some rats failed to take the bait. Another suggestion is that there were flaws in the baiting program, either that there were gaps in bait coverage or that bait was only available for a short time period.

The RSPB is committed to a second attempt and there is little doubt that they will learn the lessons of the 2011 attempt in reviewing the baiting regime in relation to the geographical conditions of the island. The suggestion that unseasonal rainfall may have affected the eradication program suggests that monitoring programs are established in the weeks preceding baiting and, in the event of stochastic events that may increase the availability of food resources, managers give consideration to delaying the program.

Eradication Programs on Inhabited islands

Eradication programs on inhabited islands are significantly more challenging in societal acceptance, operation and management, than eradication programs on uninhabited islands. Although Australia's Lord Howe Island is a World Heritage Site impacted by invasive rodent populations, while an eradication program would both be feasible and financially possible with the New South Wales and Australian governments having identified funds for a program, no eradication has yet been attempted due to local opposition. Primary concerns for residents seem to be a fear of aerial baiting and a dislike of outside interference in which the eradication program is framed as a government program which will make residents' lives more difficult. The key now for Lord Howe Island will be winning hearts and minds, as it will be for any inhabited island where eradication programs are proposed. Clear, regular and transparent stakeholder engagement is thus critical to align biological gains with the economic and social priorities of stakeholders on inhabited islands[15]. It may also ensure the long-term success of an eradication program; a community which takes pride in a program is more likely to enforce the biosecurity measures essential to ensuring its lasting success[16].

Although a Predator-Free Rakiura target was in place before the 2050 Predator-Free New Zealand target, it remains in planning. James Ware, a supervisor for DOC's Rakiura team, spoke of the challenges faced in achieving predator-free status on Stewart Island/Rakiura; during stakeholder engagement DOC found that while the local population were supportive of the aim, they were cautious about how to achieve it, with the main concern being whether the target would make life on the island more difficult. Individual concerns included the type of poison used, how the eradication program would be managed, which species would be affected and concern from the hunting community over the impact on the deer population. With just 350 residents, many of whom are employed in industries which would benefit from the implementation of the program, the struggle to advance Predator-Free Rakiura is indicative of the challenges that face eradication programs on inhabited islands.

Eradication or animal control programs on inhabited islands that use 1080 may raise concerns for dog owners, as domestic dogs are highly susceptible to the use of 1080. In Australia, when the state of Tasmania conducted a 1080 baiting program for red foxes (*Vulpes vulpes*) in July 2002, to reduce the risk posed to domestic dogs, Tasmania Parks and Wildlife and the Fox Free Taskforce produced a pamphlet, 1080 & Dogs don't mix, which was widely distributed to alert dog owners to the risk and provided advice on what to do when in a fox-baiting area. Residents were notified when fox baiting was due to take place in their locality and warning signs were placed on roads in fox-baited areas.

A fox eradication without any foxes?

If the experience on the Australian mainland is a guide, the successful biological invasion of the island of Tasmania by the red fox (*Vulpes vulpes*) could have serious ecological repercussions. Foxes are notoriously difficult to detect in low numbers and early action to address a release event, before an invasive population could become established, would be more likely to succeed than after an established population became easily detectable.

The Tasmania Parks and Wildlife Service have long maintained that physical evidence for the presence of foxes on Tasmania had been turning up since 1998, evidence that led to the launch of a AU$50m eradication program, with financing provided by the Federal government. The program was dogged by claims that foxes did not actually exist on Tasmania and that evidence was either fabricated, by members of the public or by wildlife service officials, or did not exist. ABC News later reported that as early as 2011, Simon Fearn, a zoologist with the Fox Eradication Program had raised concern that evidence of foxes being present on Tasmania was hoaxed[17]. On 4th June 2013 the Tasmanian Minister for Environment, Parks and Heritage, Brian Wightman, announced the program would come to an end and in 2014 the program was disbanded.

Whether or not there were ever any foxes established on Tasmania between 2001 and 2014 may never be known, but the program was a disaster in public engagement. The Fox Eradication Program's failure to reply to requests for information or comment from the media did little to reassure a sceptical public, media and state MP's . In the *Journal of Applied Ecology*, Stephen Sarre, of the University of Canberra, and colleagues wrote that 'we suggest that a massive upscaling of effort…is going to be required to maximize the chances of a successful eradication'[18], a statement which, in hindsight, reflects poorly on the authors and led a Tasmanian MP to write to the journal to retract the article[19]. Claims by the Invasive Species Council that the decision to shelve the program was based on 'a dismissal of science' and was 'contrary to scientific advice'[20] were inaccurate and again reflected poorly on the conservation community when a scientific review, led by fox ecologist Clive Marks, cast serious doubt on the department's claims and confirmed major anomalies in scat collection data. Marks had been a vocal critic of the fox eradication program and the issue remained dominated by polarised viewpoints.

While enthusiasm for a precautionary approach is understandable, the lessons for the management of eradication programs in the UK are clear. Confirming the presence of an invasive species, preferably by external experts, is essential before launching expensive eradication programs using public money. Equally important in maintaining public support is clear, effective and honest communication with the public, media and politicians.

Celebrating Success and Public Acceptance

A major challenge for the use of invasive species eradications as a conservation tool is public distaste for them. This is particularly true with 'cute' species, for example hedgehogs (*Erinaceus europaeus*); in spite of the impact of hedgehogs on seabird colonies on islands in the Hebrides, there is little public appetite for hedgehog eradication. The importance of winning public support for eradication programs is something New Zealand has long appreciated and sustained efforts have been made to influence public opinion on possums

Efforts have even been made to normalise the large number of possums killed every year on New Zealand roads

(*Trichosurus vulpecula*) by 'demonising the cute'. In Australia, where possums are native, the species is protected, but in New Zealand, where they have inflicted substantial damage on the native biota, they have been vilified. This approach was possible because the species could be labelled as invasive anywhere in New Zealand. Such an approach would be unsuitable for our example of the hedgehog. While hedgehogs have damaging impacts on offshore islands, on the mainland British Isles they are threatened and have undergone rapid decline. A process of their 'demonisation' could erode public support for the hedgehog's conservation on the British mainland and hasten their demise. In such cases, a program of live trapping and removal to the mainland may be more appropriate than eradication.

Celebrating success is an alternative method for winning public support, in the effort to make the end result of the eradication program (a haven for endemic or endangered species) something which stakeholders feel proud of. One example of this approach was the Macquarie Island multi-species eradication, which sent film crews to Macquarie Island with the field teams, in order to document the project's success. .

South Georgia: Governance, International Collaboration and Invasive Species

A positive example of articulating the benefits of an eradication program on the BOTs is the rodent eradication program on South Georgia (2011-2015). The Government of South Georgia and the South Sandwich Islands proposed the eradication[21], but, as shown in *Governance*, lacked the resources[22 23] to perform a program that was on a magnitude greater than any comparable eradication program[24]. It was, therefore, a small charity, the South Georgia Heritage Trust, which advocated for an eradication program and raised the funds (£7.5m in 2015) to do so through donations from private individuals and foundations. The program was completed over a multi-year period, by adapting strategy to geographical conditions (for example, glacial boundaries defined distinct rodent populations which could be targeted individually) and drawing heavily on international expertise, particularly from New Zealand. The rodent eradication on South Georgia is an excellent example of how international collaboration and the sharing of best practice can enable a small charity or NGO to complete ambitious island conservation projects.

5. Management of High Priority Species

High priority species for island conservation tend to be endemic species. These species are often considered highly vulnerable under IUCN guidelines, because the population is often known from a single population on a single island, putting them at tremendous risk, for example from stochastic events or biological invasion. This has meant that two of the most valuable direct interventions have been **Captive Breeding** and **Translocation**.

Captive Breeding

Captive breeding of high priority island species may achieve several immediate conservation goals. With species restricted to a single island or population, one of the most important is to serve as a reserve population. A reserve population serves as a potential insurance against extinction due to the impact of a single stochastic event, as happened to the plant *Xylosma serrata*, which is thought extinct after its only known habitat on the BOT of Montserrat was destroyed by a volcanic eruption and no ex-situ material existed[25], or biological invasion of the species' only known habitat, as was the case for the South Island snipe (*Coenocorypha iredalei*) when the species' final refuge, Big South Cape Island in New Zealand, was invaded by black rats (*Rattus rattus*), an event which the species, reduced to two individuals, was unable to recover from. A reserve population both immediately prevents extinction and serves as a reserve gene pool for species reduced to only a few individuals in the wild.

Captive breeding programs can also be used with the intention of directly increasing the recruitment rate in high priority species, by increasing the survival rate to maturity, providing an immediate boost to wild populations. The Otanewainuku Kiwi Trust suggest that just 5% of kiwi (genus *Apterygidae*) chicks survive their first 6 months, but captive breeding programs for kiwi are thought to have as high as 65% survival rate over the same period if fledged in captivity to a weight of 1kg (Paul Kavanagh, pers. com., 21st April 2017).

Perhaps the most famous example of the success of a captive breeding program in the survival of an endangered species is that of the black robin (*Petroica traversi*) from New Zealand's Chatham Islands, which was brought back from a population low of just 5 individuals. Breed-for-release programs now exist for many New Zealand endemics, including the takahē (*Porphyrio hochstetteri*) and kakapo (*Strigops habroptila*), while in Australia a priority breed-for-release program is that for the Critically Endangered orange-bellied parrot (*Neophema chrysogaster*) which is only known to breed in Tasmania and has a global wild population which numbers less than 30 mature individuals[26] and perhaps as low as 14[27]. A captive breeding population of 300 orange-bellied parrots also serves as an insurance population against extinction.

Captive breeding will be likewise essential to the survival of several British endemic species, none more so than the bastard gumwood tree (*Commidendrum rotundifolium*). Endemic to St Helena, the species was reduced to just 1 known individual in the wild and, since the discovery of a second individual, has since had a number of saplings cultivated at three locations, notably at Drummond's Point[28]. The species remains Critically Endangered.

Translocation

Translocation is regularly used as a management technique in island conservation in order to establish new populations on different islands (or the mainland), to prevent genetic bottlenecks in small island populations by actively managing the gene pool, as well as to repopulate areas where the species was previously extirpated due to habitat loss or biological invasion and which have since been restored.

Establishing new populations on different islands, like captive breeding programs, acts as an insurance against stochastic events or ecological threats devastating the only known habitat of an endangered island species. Johannes Fischer, a PhD student at Victoria University, in New Zealand, studying a potentially distinct population of South Georgian diving petrel (*Pelecanoides ssp.*), suggested that a translocation may be necessary in the future, citing the impact of a storm in 2004 that resulted in the loss of an estimated 40% of nests that year and 15% of the population. Iwi approval would be essential for a translocation and correct site location would be critical: the species requires a predator-free dune system. Dundas Island and Enderby Island on the Auckland Islands have large sea lion populations which may pose a threat to the safety of burrows. Campbell Island may be ideal but is 500 km from the current population on Codfish Island/Whenua Hou. Managers, however, could create a habitat island by fencing a section of the dune system on the Otago Peninsula.

In New Zealand, Little Barrier Island/Hauturu and Tiritiri Matangi have been recipients of extensive translocations and are now used as source populations. Concern has been raised about the genetic viability of subsequent translocations, drawing on a subsection of an already restricted gene pool, but DOC now has a nuanced strategy to genetic viability, with a genetic database for high priority species. Translocation can also be used in conjunction with restoration projects as a temporary measure for an area. For example, the remaining 8 kokako (*Callaeas wilsoni*) of Otanewainuku Forest in the Bay of Plenty were removed in 1985 to Little Barrier Island. A pest control program was implemented and in 2009 the program had been declared successful enough for DOC to reintroduce Kokako.

Translocation is not always effective. The bushwren (*Xenicus longipes*) survived on predator-free Big South Cape Island until the island was invaded by ship rats (*Rattus rattus*) in 1964. In a strategy emulated in later, successful, translocations, DOC's forerunner, the New Zealand Wildlife Service, translocated the entire global population, which numbered just six individuals, to Kaimohu Island, but the species never recovered and went extinct in 1972.

Tasmanian Devil – *Save the Tasmanian Devil Program*

Tasmania's endemic mammal, the Tasmanian devil, is a priority species for conservation on the island state

Tasmania's iconic species, the Tasmanian devil (*Sarcophilus harrisii*) is the world's largest carnivorous marsupial. Once present on the Australian mainland (likely extirpated 1000-1500 years ago), the Tasmanian devil is now restricted to Tasmania and offshore Maria Island, where it was introduced in 2012. Devil facial tumour disease (DFTD) has swept through the population since 1996 and is now considered the primary threat to the species, ahead of road traffic collisions and human-wildlife conflict over livestock predation. Maria Island hosts a 'DFTD-free' population of Tasmanian devils, as do remote areas of Tasmania's south-west and north-west.

Conservation efforts are led by the Department of Primary Industries, Parks, Water and Environment's Save the Tasmanian Devil Program. There is some hope of disease resistance developing among wild populations, or the development of a vaccine, but management efforts are currently focussed on managing the wild 'DFTD-free' populations on Maria Island and the Forestier and Tasman Peninsulas, as well as restoring ecosystem function and increasing local genetic diversity in selected DFTD-infected areas via supplementary translocations (referred to as 'Wild Devil Recovery'). Captive-bred Tasmanian devils are translocated to Maria Island and the Peninsula to maintain genetic diversity, while wild-born devils are translocated from those populations to supplement diminished wild populations elsewhere in Tasmania. A translocation from Maria Island to Mount William/Wukalina was successfully conducted at the time of fieldwork.

Several proposals have been put forward to reintroduce Tasmanian devils to mainland Australia, however the Save the Tasmanian Devil Program currently remain focussed on management of the species in Tasmania. Reintroductions to the mainland would need to address issues such as threats to devils and suitability of habitat, the combined impacts of devils and introduced predators on native fauna, and potential conflict with other land users.

Takahē - ***Kakapo/Takahe Recovery Team, Department of Conservation***

The takahē was previously thought to have been extinct since 1898

The world's largest rail, the takahē (*Porphyrio hochstetteri*), was thought extinct until its rediscovery by Geoffrey Orbell in 1948. Although the species had suffered from over-hunting and loss of habitat, as well as predation and competition by different invasive species, Orbell found a surviving population in the Murchison Mountains near Lake Te Anau. Conservation management was slow to act due to a lack of available resources and disagreement over strategy between non-interventionists, who initially sought to protect the species in-situ by protecting the rediscovered population under Fiordland National Park, and interventionists, who advocated the need for active management making use of translocation and captive breeding. Conservation of the Murchison Mountains site was eventually coupled with translocation of individuals to predator-free offshore island sanctuaries (Maud Island, Motutapu Island, Mana Island, Kapiti Island and Tiritiri Matangi Island).

Now managed by DOC's joint Kakapo/Takahē Recovery Team, the takahē benefits from the increased resources available to this specialist team, a benefit of joint species teams, and the population has risen to 306 individuals, although that remains short of the aim of 500.

One of the most persistent threats to rare British bird species has been the removal of eggs by egg collectors. Andrew Digby, a British scientist with the Kakapo/Takahē Recovery Team, noted that the threat of egg collectors has never been a significant issue for conservation in New Zealand, suggesting that a concerted emphasis on advocacy was key to this.

Kakapo - ***Kakapo/Takahe Recovery Team, Department of Conservation***

Kakapo (Department of Conservation)

Also overseen by the Kakapo/Takahē Recovery Team, the Critically Endangered kakapo (*Strigops habroptila*) is among New Zealand's most iconic endemic species. Advised by the Kakapo Recovery Group, with Iwi representatives among its members, the Department of Conservation Kakapo/Takahē Recovery Team are responsible for conservation efforts for the Kakapo. Kakapo populations have now been established on Codfish Island/Whenua Hou, Anchor Island/Puke Nui and a test population of 10 individuals on Little Barrier Island/Hauturu, although each population remains small. All three islands are predator-free, although there is theoretically the possibility of mustelids swimming to Anchor Island, and all three are publicly inaccessible: Codfish Island/Whenua Hou and Little Barrier Island/Hauturu are restricted access islands, while Anchor Island/Puke Nui is geographically remote. With the population divided between three small populations, careful management of the species' gene pool remains a priority as there is significant concern regarding the species going through a genetic bottleneck.

One of the best funded teams within DOC through its long-standing model of private partnerships, made possible by the iconic species it works with, the Kakapo/Takahe Recovery Team are able to conduct their activities without draining DOC's finances, freeing up resources elsewhere. Sirocco Tours, named after their star and the world's most famous kakapo, constitute the sole outreach involving living kakapo and can connect with 4,000 – 12,000 people a year.

The kakapo is an excellent case study for the UK for the management of a Critically Endangered species, as well as how private-public partnerships can be marketed to business and harnessed for conservation objectives.

Black Robin – *Black Robin Project*

Black robin (Department of Conservation)

The most endangered bird species in the world by the end of the 1970's, the black robin (*Petroica traversi*) reached a population low of just 5 individuals on a single island, Little Mangere Island, with only 1 breeding female. Brought back from the brink using a cross-fostering approach to captive breeding and translocation to Mangere Island, the population now stands at 250 individuals spread between the two Chatham Islands to reduce the risk posed by stochastic events.

After an intensive effort to rescue the black robin from extinction in the 1980's through to 1998, led by Don Merton, a former New Zealand Churchill Fellow, DOC monitoring of the black robin had lapsed by the early 2000's. The Black Robin Project was formed in 2007 and Melanie Massaro led the first study of the black robin since monitoring and conservation management had lapsed a decade earlier, but since the DOC restructure in 2013 has struggled with bureaucracy imposed by the department on working with the species, leading to the decision being taken not to conduct fieldwork in 2016. The lack of currently ongoing research into such a high profile species should be a concern for the scientific community, although there is hope that fieldwork will resume in subsequent years.

As well as being a world famous example of the use of a captive breeding program to save a species from extinction, the black robin illustrates the importance for the UK of maintaining monitoring programs for endangered endemics beyond an active intervention. The Black Robin Project additionally runs a website (http://www.blackrobin.org.nz/) which provides educational resources for primary and secondary schools, aimed at highlighting the case of the black robin and importance of island conservation.

6. Innovative Technology

Innovative technologies offer the opportunity to more effectively and efficiently combat biodiversity erosion on island systems. With the most ambitious island conservation targets of any country, New Zealand offers insight into how innovative technology might be utilised. Some innovative technologies are already in use, others still require extensive research before they become a reality. Practitioners interviewed for this project across New Zealand widely accepted that the 2050 Predator-Free New Zealand target was impossible to achieve over such a large area with current methods and funding. Hope in achieving the 2050 target has therefore largely been placed in innovative technologies. In this section, I review some of the most promising techniques to have emerged and assess their potential uses and limitations.

What is the value of the Predator-Free New Zealand 2050 target?

It would be reasonable to question the value of New Zealand's Predator-Free 2050 target if most practitioners accept that the target is impossible to achieve within the time frame set, without significant increases in investment which are unlikely to be forthcoming in light of recent DOC budget cuts.

Most practitioners, however, also considered that the target was still important because it attracted media attention and therefore successfully raised the public profile of the impact of invasive species. Keith Springer, who is serving as an operational advisor to the RSPB's restoration program for Gough Island, also noted that the target gave a goal for conservationists to measure progress against.

Gene Drive Technologies

Recent developments in gene drive technologies have led to interest in their use to control invasive species. Webber et al. (2015)[29] review the potential for such use and conclude that developments in CRISPR-Cas9 gene drive technology means that the use of such technologies to control invasive species is now possible, but not without risk. The major risk is that a species targeted by gene drive technologies would be vulnerable to being driven to extinction, but any application should also consider potentially significant ecosystem-wide implications and unintended consequences.

To determine the risk to the target species, dispersal ability is key: the authors believe that such technologies may be feasible for invasive species with poor dispersal abilities where less of a threat is posed to the species in its native range, for example amphibians on offshore islands, but poses too high a risk to use in the marine environment or where the targeted species is readily dispersed, for example wind-dispersed grasses.

They pose the key question whether "we are willing to risk the global loss of a species as a result of unintended dispersal of modified individuals back to their native range, to benefit from the control efficiencies that CRISPRCas9 gene drive technology could offer?"[30]

RNA Interference (RNAi)

While development is still ongoing, RNAi offers the potential to be a viable species-specific toxicant that meets euthanasia criteria. While development of the technology may be rapid, although the fact that RNAi technology is largely controlled by patents would prove an obstacle to the development of RNAi pesticides, RNAi may be controversial if linked to genetic engineering[31]. It would also require extensive field and clinical trials to address the lack of data on its impact on the environment in which it is used, in order to satisfy the requirement that its use is deemed of acceptable risk.

Chemical Sterilants/Contraceptives

The drive for so called 'safe sterilisation' is a potential alternative to lethal control of invasive species. There are a range of approaches to sterilisation, but the approach is generally considered humane and compliant with welfare considerations[32], although there is a longer lag time before eradication than lethal control. Chemical sterilants may have some of the same concerns as the application of conventional poisons, namely impact on non-target species.

Virus-vectored immunocontraception (VVIC) is one method of contraception which utilises viruses as a vector to reduce reproductive potential. The advantages of VVIC specifically is that some consider it may be environmentally benign[33], while compared to conventional control methods it could potentially be cheaper as it is to an extent self-disseminating. Much like concerns over chemical sterilants are associated with the impact on non-target species, there is likewise a concern with VVIC of unanticipated impact on non-target species through the zoonotic transmission of infectious agents. Other concerns include the genetic engineering of a vector, irreversibility, the difficulty of controlling vectors, the potential for the development of host resistance and the risk of irreversible genetic alterations to the target species through selection[34].

For VVIC to be a reality will thus require considerable further research, and therefore significant investment, particularly as the research program to develop a mouse VVIC is no longer being financed by the Australian Invasive Animals Cooperative Research Centre[35].

Drone technology

The rapid growth in public use of Unmanned Aerial Vehicles (UAV) has led to increased interest in their application for island conservation objectives. The most likely use of drone technology would be in invasive species eradication programs, where drones could be used to deliver bait to remote locations, or for night detection surveys along pre-programmed routes and where a civilian helicopter pilot's reliance on using lights, combined with the noise of the helicopter, may cause the target species to flee. Drone technology is expected to be widely used in eradication programs within a decade[36].

Limitations to the use of drone technology include legislative restrictions to their use (in the UK the use of drones to distribute pesticide is not permitted, limiting their current usability to deliver bait in eradication programs), operative limitations of most market drones in high wind conditions, as would be faced on many of the South Atlantic BOTs in particular, and public objections to their use, for example in National Parks.

Resetting traps

The first of several examples of innovative developments of old technologies, resetting traps were pioneered by Goodnature, a New Zealand-based manufacturer, in partnership with DOC. The best resetting traps are all based around the design of a humane kill trap for invasive species that then resets itself, a model which prevents the need for labour intensive and expensive daily trap checking.

Ross Kerr, a former DOC Ranger illustrated the problem of trapping in remote Fiordland National Park: the national park is so large and so inaccessible that traps were traditionally limited to being set along access paths. Removing the need for daily trap checking also allows traps to be set away from easily accessible routes.

Artificial reef unit (Reef Design Lab)

Artificial Reef Design

A potentially useful restoration technique for the marine environment surrounding islands, artificial reed design is another example of an idea that has been around for a long time, but which has seen fresh insight in recent years. Australian manufacturer Reef Design Lab has highlighted the importance of the use of fluid dynamics to create artificial reef units that resemble a natural reef structure.

With the establishment of the UK Marine Protected Areas (MPAs) and a shift in policy focus towards the island marine environment, Alex Goad, of Reef Design Lab, noted that the establishment of ecologically-effective artificial reefs in target areas around the British Isles would help the recovery of areas devastated by beam-trawling, one of the impacts of which was the levelling of a previously three dimensional environment.

Case Study: Application of Innovative Technology to Albatross Conservation

One of the world's most majestic seabirds, the albatross family have the largest wingspan of any bird alive and spend the majority of their lives at sea, returning to land to breed. New Zealand's subantarctic islands have globally significant albatross populations, as do the UK's South Atlantic BOTs[37]. Of the 22 albatross species worldwide all are considered of some concern by the IUCN and 3 species are listed as Critically Endangered.

Albatross conservation requires innovation at sea and on land. One of the major threats to albatross is entanglement on fishing line from commercial longline operations. Faster sinking (weighted) lures protect seabirds, but are unpopular among fishermen as they are more dangerous for the men. Several other innovative technologies have been proposed and put in place within more responsibly managed fishing zones, including the Falkland Islands BOT. These include 'bird bashers' to scare albatross away from trawlers, flags over trawler nets to keep seabirds away, setting bait underwater[38], setting longline bait at night, or even dyeing bait blue.

Albatross are also threatened by invasive species on the islands where they breed. This includes Gough Island on the BOT of Tristan da Cunha, where mice eat both eggs and the chicks of the Critically Endangered Tristan albatross (*Diomedea dabbenena*) alive. A mouse eradication program is scheduled for Gough Island in 2019.

A third threat to albatross is from ocean plastics, the ingestion of which has long been known in albatross and has been shown to cause physiological stress and a reduction in food intake in albatross chicks, thus reducing the chance of survival[39]. The impact of ocean plastics is another example of the importance of the marine environment in conserving island biodiversity.

Stewart Island/Rakiura's Paterson Inlet, New Zealand, plays host to albatross from the Southern Ocean

7. Conclusion and Recommendations

Island conservation requires policymakers and practitioners to utilise different approaches to continental conservation, but they should also take into account geographical island type (offshore/habitat island; uninhabited/inhabited; oceanic/continental), which should have considerable bearing when designing conservation strategy. Taking into account individual geographies, selecting suitable comparative reference examples can help guide strategy and may save time and resources, as well as increasing the chance of success of any intervention or policy. New Zealand, Australia and Fiji offer alternative approaches to island conservation. The key lessons that they offer for the UK are grouped into 6 categories:

- Increasing Public Engagement with Island Conservation

- Monitoring and Incorporating Innovative Techniques

- Updating and Improving Response to Invasive Species

- Protecting High Priority Species and Environments

- Formalising Channels for Sharing Best Practice and Skills

- Thinking Big: The Benefits of Ambition

1. Increasing Public Engagement with Island Conservation

The example of New Zealand highlights the benefits of building public awareness and engagement with island conservation. Awareness of island conservation in the UK remains poor, from knowledge of the BOTs[40], to specific topics within island conservation, such as the impact of invasive species, which The Great Britain Invasive Non-Native Species Strategy acknowledges is poor among both the public and government departments[41].

This report finds that increasing the public profile of island conservation, particularly among young people, the UK's future conservation practitioners, could have considerable benefits. The RSPB's free education outreach visits are good introductions to conservation, but this report recognises the need to expand the program and proposes the development of an island conservation session in addition to those offered. A curriculum introduction to the BOTs would both increase public knowledge of the BOTs and of their conservation.

This report repeatedly finds that the RSPB, largely unnoticed by the British public, plays an important part in island conservation on the BOTs, often in a role that would be expected elsewhere of national (New Zealand), or state (Australia), government. Celebrating success in widely accessible formats will increase public awareness of BOT conservation and may contribute to public support or resources for the RSPB to continue that success.

The author makes the following recommendations:

- The long-term goal of an introduction to the BOTs incorporated in the secondary education curriculum (Geography/Biology).
- Environmental education providers, including the RSPB education team, should aim to offer an introduction to island conservation in the UK.
- An increasing focus on and promotion of the RSPB's work on the BOTs in published and screen media would be beneficial.

2. Monitoring and Incorporating Innovative Techniques

There have been a number of recent innovative developments with application to island conservation, especially invasive species eradication programs. While these offer hope for the future, many remain in development. Of particular interest are:

- The deployment of humane, self-setting traps prioritised over conventional traps, during trapping regimes.
- The incorporation of developments in artificial reef design by island restoration practitioners, in consideration of the significance of the marine environment for island biodiversity. Particularly relevant in areas previously damaged by beam trawling.
- Managers should monitor the academic literature for developments in innovative technology, ensuring that any proposed meets the principle of acceptable risk.

3. Updating and Improving Response to Invasive Species

Incorporating a proactive approach into The Great Britain Invasive Non-Native Species Strategy, the document which governs Defra's response to biological invasions, could prove to be effective and may lead to significant cost savings in the long-term.

Biosecurity regulation for the metropolitan UK is weak compared to respective programs in Australia and New Zealand. Introducing more rigorous biosecurity measures are unlikely to be effective however, due to the volume of travel through major UK airports, without significant investment in recruiting and training additional biosecurity and customs officers. Even then it is likely that the UK would struggle to implement rigorous measures effectively because of the challenges for customs officers to perform biosecurity checks on vehicles travelling between the continent and the British Isles in sufficient intensity to be effective.

More rigorous biosecurity regulation would, however, be effective and appropriate for the BOTs. Invasive species pose a higher risk to the BOTs, as oceanic islands, and their geographical isolation and lower visitor numbers would make the implementation of biosecurity measures feasible. South Georgia and the South Shetland Islands have already implemented an effective biosecurity strategy which mirrors programs seen in New Zealand and Australia. With the threat posed by invasive species to the BOTs' endemic species well documented[42], more rigorous regulation seems appropriate.

New Zealand officials were openly disappointed about the lack of progress the UK had made in tackling invasive species, particularly on the British Isles, citing a perceived lack of ambition and political will to address the challenge. Paul Kavanagh, of the Kiwi Birdlife Park, who has worked in New Zealand and on the British Isles, noted there are, however, limits to what can be transferred directly from New Zealand's success. New Zealand's native biota lacks mammals (except two native bat species), which makes non-discriminatory trapping of terrestrial mammals possible. On the British Isles such an approach is not feasible, for example accidently trapping red squirrels (*Sciurus vulgaris*) instead of grey squirrels (*Sciurus carolinensis*) would be detrimental.

In cases where an eradication program is not currently possible or desirable, the use of trapping programs can reduce invasive populations to acceptable levels and should use humane, self-resetting traps.

- BOT Governments introduce more rigorous biosecurity measures, in line with that of South Georgia and the South Shetland Islands.
- Conservation organisations making targeted use of humane, self-resetting traps to control invasive species populations to acceptable levels.

4. Protecting High Priority Species and Environments

Case studies of the conservation of high priority species in the study countries suggest a range of measures that may be applied to support conservation efforts. Two of the most important are the use of translocation and captive breeding to establish off-island populations of Critically Endangered and Endangered endemic species. Although there have been substantial efforts made to increase the banking of seeds, over 85% of known plant species are not yet held in the world's largest seedbank, RBG Kew's Millennium Seed Bank, while many endangered species (both animals and plants) are not secured in off-island populations. For example, only one of the nine endemic vascular plants on the Pitcairn Islands is secured in an off-island population and in RBG Kew's Millennium Seed Bank.

The BOTs, which host 94% of known British endemic species[43] and have biotas heavily represented by the most vulnerable species to ocean plastic pollution (seabirds, marine animals), are also among some of the regions most afflicted by ocean plastic pollution. The South Pacific Gyre means that the UNESCO World Heritage Site of Henderson Island suffers from the worst ocean plastic pollution of any island in the world[44]. A lack of human habitation on many BOTs and their offshore islands, as well as relatively few visitors, means that there is a lack of human responders to collect plastic along the coastline.

- Establish off-island populations of all Critically Endangered and Endangered British endemics through translocation and captive breeding populations, as a matter of urgency.
- Investigation by the RBG Kew Millennium Seed Bank Partnership into the possibility of involving universities in collection efforts, in order to collect seeds for all seed-bearing British endemic plants.
- Increased leadership by the UK and BOTs governments to address plastic pollution on BOTs. This would include collecting plastic pollution (for example, by encouraging partnership between communities and cruise operators to run clean-ups) and spearheading efforts to tackle plastic pollution at its source (through international commitments to reduce plastic pollution originating from the UK's jurisdiction, while pushing for similar commitments from partner states).

5. Formalising Channels for Sharing Best Practice and Skills

Progress is being made in the sharing of best practice among island conservation practitioners. Particular success has been made in eradication programs and there is evidence of this being incorporated into strategy, with the UK Rodent Eradication Best

Practice Toolkit based on the New Zealand Department of Conservation's Best Practice for Rat Eradication – Bait Station[45] and the Pacific Invasives Initiative Resource Kits, with advice provided by DOC's Island Eradication Advisory Group.

Geographically, there has been particular success in the sharing of best practice in the South Atlantic region. The South Atlantic Invasive Species Strategy and Action Plan praises South Georgia's success, supported by thorough quarantine procedures and new island biosecurity facilities, noting that "sharing experiences and skills, the South Atlantic (British Overseas Territories) have the chance to reduce the negative impacts of invasive species" [46]

- Formalising communication channels between UK practitioners and their overseas counterparts is recommended to allow for the continuous and timely sharing of best practice and skills, as necessary.
- The Pitcairn Islands joining the LMMA network would allow for formalised support from the network for the BOT.
- Experiences from eradication campaigns should be shared in online databases (e.g., Island Conservation's Database of Island Invasive Species Eradications)

6. Thinking Big: The Benefits of Ambition

What sets New Zealand and DOC apart is level of ambition, in contrast to the UK's perhaps unambitious approach to island conservation. Predator-Free New Zealand 2050 represents the single most ambitious island conservation target of its kind that the author is aware of.

A more ambitious approach may require a more active role for the UK government in BOT conservation. For example, Gough Island is a World Heritage Site, under a convention signed by the UK government, where Critically Endangered British species are at risk. With that signature comes management responsibilities, but it is the RSPB which has led intervention efforts and fundraising for a mouse eradication program (of which the UK government has contributed about a fifth). As highly devolved entities, a more active role must be one of partnership with BOT government, as well as civil society, in which the UK government acts as a source of expertise, advice and resources.

- Adopting an ambitious government agenda for island conservation, set by Defra in consultation with the FCO and BOT Governments. At a minimum, the UK should aim to fulfil its target of zero species loss across its entire jurisdiction, including the BOTs, not just the metropolitan UK.
- UK government providing increased support to Territory Governments in logistics, expertise and funding for ambitious projects where appropriate.

Moving Forwards

The next steps for this project will be to head west to the South Atlantic, where I will be looking at island conservation on the British Overseas Territories in the Atlantic. Fieldwork will commence on 22nd October 2017 on the Falkland Islands. A policy paper for Defra on island conservation in the UK will be developed on the basis of the report's findings.

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Glossary

BOT – British Overseas Territory (also Overseas Territory)

Critically Endangered (CR) – A species is Critically Endangered when the best available evidence indicates the species is facing an extremely high risk of extinction in the wild.

Defra – Department for Environment, Food and Rural Affairs, UK

Devil facial tumour disease (DFTD) – A non-viral transmissible parasitic cancer that affects Tasmanian Devils. First observed in 1996.

DOC – Department of Conservation, New Zealand

Endemic – Native only in one country or area, or restricted to a specific region

Endangered (EN) – A species is Endangered when the best available evidence indicates the species is facing a very high risk of extinction in the wild.

FCO – Foreign and Commonwealth Office, UK

FLMMA – Fiji Locally Managed Marine Area Network

IEAG – Island Eradication Advisory Group, Department of Conservation, New Zealand

Invasive – A non-native species which causes considerable damage to the environment, economy or human health.

Iwi – A specific Maori community

IUCN – International Union for Conservation of Nature

LMMA – Locally Managed Marine Area Network

NGO – Non-governmental organisation

Non-native (alien species) – A species introduced to an area outside of its natural (past or present) distribution.

OT – Overseas Territory (also BOT)

RSPB – Royal Society for the Protection of Birds

UNDP – United Nations Development Programme

WCS Fiji – Wildlife Conservation Society Fiji

WiFN-Fiji - Women in Fisheries Network – Fiji

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