DUSKY SOUND CONSERVATION AND RESTORATION PLAN

providing outstanding ecological services to sustain and improve our environments

Wildlands

R3111

DUSKY SOUND CONSERVATION AND RESTORATION PLAN

Contract Report No. 3111

June 2013

Project Team:
Kelvin Lloyd - Report author
Rachel McClellan - Report author
Steve Rate - Report author
Mandy Tocher – Report author
Lucy Jack - Report author
Richard Gillies - Report author
Kerry Borkin - Report author
Brian Patrick - Report author
William Shaw - Report review

Prepared for:
Department of Conservation
Te Anau Area Office
Southerland Conservancy
P.O. Box 29
Lakefront Drive
Te Anau 9600

DUNEDIN OFFICE: 764 CUMBERLAND STREET, DUNEDIN 9016
Ph 03-477-2096; 03-477-2095

HEAD OFFICE: 99 SALA STREET, P.O. BOX 7137, TE NGAE, ROTORUA
Ph 07-343-9017, 07-343-9018; email ecology@wildlands.co.nz, www.wildlands.co.nz

"…[Resolution and Secretary] islands are peculiarly suitable for birds, such as pigeons, kakas, ducks, and particularly kiwis" (Martin H. 1885: The protection of native birds. *Transactions and Proceedings of the Royal Society of New Zealand 18*: 112-117)

"Our kiwis, with our kakapos, are being wiped out of existence … the day of the wingless bird is over. Save only on our sanctuary islands are the birds common, on Stewart Island, Resolution Island, Kapiti, and the Barriers" (Fulton 1907: The disappearance of the New Zealand birds. *Transactions and Proceedings of the Royal Society of New Zealand 40*: 485-500)

EXECUTIVE SUMMARY

This report comprises an integrated ecological conservation and restoration plan for the Dusky Sound project area, which includes all of the terrestrial and marine ecosystems within Dusky Sound, Breaksea Sound, Wet Jacket Arm, and Acheron Passage, including important mainland buffer zones which have intrinsic values, provide additional high quality habitat, and will enhance the protection of established or proposed pest control areas. This plan contains a strategic assessment of where to direct conservation effort, and why.

Dusky Sound has a significant human history, but light human footprint. Remains of cave dwellings, ovens, storage pits, huts, canoes, tools, and middens demonstrate seasonal Māori occupation prior to European colonisation. European history includes the mooring of Captain Cook's vessel in Dusky Sound for five weeks in 1773, the first landing of a European sealing gang on Anchor Island in 1792, the first European shipwreck in Facile Harbour, the reservation of many Fiordland coastal islands in the early 1890s, and a pioneering attempt by Richard Henry to protect indigenous bird populations by transferring them from the mainland to Resolution Island in the late 1890s to early 1900s. Dusky Sound, along with the other fiords, was a cornerstone of New Zealand's early tourism industry from the 1870s. Current human activities in the Dusky Sound area include commercial fishing, commercial venison recovery, recreational fishing, tourism (including cruise ships), tramping, and hunting.

Management of the project area and its values is governed by a range of statutes and agencies, which requires coordinated action to achieve objectives, particularly those relating to the marine environment. Terrestrial habitats are part of Fiordland National Park, while marine habitats are mainly unprotected but include a mix of marine reserves, commercial exclusion zones, 'china shops' (where anchoring is restricted, to protect fragile encrusting communities), and open seas.

The marine environment is representative of western Fiordland fiords and fiord complexes. It is characterised by extremes of salinity, wave action, and irradiance that, together, influence patterns in productivity. The coastline is generally steep, rocky, and exposed. The fiords are full of coves and contain numerous islands and islets, the largest of which is Resolution Island (20,890 ha). Over 700 islands are present in the project area, but the vast majority are very small. Forty-three islands are larger than 4 ha, 28 are larger than 10 ha, and only six are larger than 100 ha.

Indigenous vegetation cover across the project area is intact, although its composition is being adversely affected by red deer browse damage. The possum-free status of islands in the project area means that indigenous mistletoe assemblages are essentially undisturbed, although at relatively low abundance. Podocarp/beech forest and beech forest covers most of the terrestrial surface, with subalpine scrub above the treeline and alpine tussock grassland at higher elevations. Manuka and *Chionochloa acicularis* are locally dominant in poorly-drained lowland habitats, mostly on peat. Coastal scrub and herbfield occur extensively on exposed coastal sites.

One Threatened, nineteen At Risk and four other notable vascular plant species have been recorded within the project area. Fourteen Threatened, 29 At Risk, five Coloniser or Migrant, and 20 Not Threatened indigenous bird species have been recorded in the area, including a wide range of seabirds and forest birds. The At Risk Fiordland skink is well known from the

area. Eight indigenous fish species (five classified as At Risk) and koura have been recorded in freshwater habitats. Several important terrestrial invertebrates, including eight At Risk taxa, are present within and near the project area. The Dusky Sound project area also supports significant seal colonies and a population of bottlenose dolphin with Critically Endangered status.

There are no substantial populations of any terrestrial weeds of conservation concern and no known aquatic weed species. Gorse is present but has a limited distribution. Terrestrial indigenous fauna populations are threatened by introduced pest animals, particularly stoats and rodents. However, most of the islands in Dusky Sound have never been invaded by possums, and some islands have had few or none of the four rodent species or stoats, and are in near pristine condition. Successful pest animal eradications have been undertaken for Norway rat (Hawea Island and Breaksea Island), stoats and deer (Anchor Island and its outlying islands), and Norway rats (Indian Island). Stoat and deer control is currently undertaken on Resolution Island and stoat control has recently begun on Long Island. Deer are still present on Resolution Island, although numbers have been greatly reduced.

In total, approximately 1,500 ha of island habitats are free of pest animals, while another 25,000 ha have reduced pest assemblages, especially Resolution Island which is free from possums and rats, and where control (and potential eradication) of mustelids and deer is being actively pursued. This island assemblage is a very significant conservation resource in its own right, having an intact cover of primary indigenous vegetation, a diverse range of habitats, and direct linkages to marine protected areas; adding considerable strategic weight to any conservation activities undertaken in the Dusky Sound project area.

This plan sets out four conservation and restoration goals:

Goal 1: Natural ecosystems, ecological processes, and species are protected by eliminating or controlling to sufficiently low densities marine and terrestrial pest species and by preventing the establishment of new pest species.

Goal 2: Terrestrial ecosystems within the Dusky Sound project area are enhanced through reintroduction of missing (or analogue) species, and biodiversity information gaps are progressively filled.

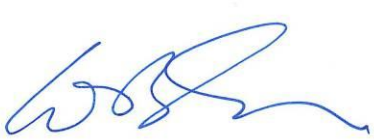
Goal 3: Marine ecological functions, habitats, and populations of indigenous species within the Dusky Sound project area are protected and marine-terrestrial interactions are enhanced and marine biodiversity information gaps are progressively filled.

Goal 4: Iwi, stakeholders, and community are involved in and support all aspects of the Dusky Sound conservation and restoration project. Historic, cultural, and recreational values are not significantly diminished by biodiversity conservation actions, and biodiversity values are not compromised by visitor use.

Fifty-four objectives and associated actions have been developed in order to achieve these goals. The objectives cover vegetation and habitat mapping, pest animal and weed control, translocations, monitoring, advocacy for additional marine protection, and filling information gaps relating to seabirds, lizards, bats, terrestrial invertebrates, freshwater fish, mapping, marine mammals, and fragile marine encrusting organisms. If these objectives can be achieved, the Dusky Sound project area will continue to make a major contribution to biodiversity conservation in New Zealand, which will increase over time.

CONTENTS

Reviewed and approved for release by:



_____

W.B. Shaw
Director/Principal Ecologist
Wildland Consultants Ltd

1. INTRODUCTION

Dusky Sound is located in Fiordland National Park, on the south-western coast of New Zealand. The Dusky Sound project area includes Breaksea Sound, Acheron Passage, Wet Jacket Arm, and Dusky Sound itself, together with over seven hundred large and small islands, including the *c.*20,000 ha Resolution Island. This report comprises an ecological restoration plan for the Dusky Sound project area, which has been selected by the Department of Conservation as a nationally important site for pest eradication and translocations of threatened species, under the Fiordland Islands Restoration Programme. The restoration plan has a 30-year time frame, but it is anticipated that it would initially be reviewed after two years and then at five-yearly intervals.

Dusky Sound has a significant human history. Archaeological records of past inhabitation by Māori includes cave dwellings, ovens, storage pits, huts, pieces of canoes, barked trees, hut sites, tools and other artefact finds, and middens (Appendix 1). Two principal trails, an inland route and a sea route around the fiords, linked the Fiordland coast with the rest of Te Wai Pounamu (the South Island). Hence, tauranga waka (landing places) occur up and down the coast, and wherever a tauranga waka is located there is also likely to have been a nohoanga - fishing ground or kaimoana resource - with the sea trail linked to a land trail or mahinga kai resource (Department of Conservation 2007). Huts are thought not to have been permanent structures, reflecting the seasonal nature of Māori occupation (Coutts 1969).

Dusky Sound is also a significant site in the history of European exploration and colonisation. Captain Cook spent five weeks (mid-March to late April) in Dusky Sound in 1773, while the astronomer William Wales tested the newly-invented ship's chronometer for determining longitude, and in doing so established the longitude and latitude of New Zealand. Meanwhile Resolution was repaired and refitted, and spruce beer was brewed using rimu to ward off scurvy. During the stay, Cook and the crew met a Māori family; the only recorded encounter with Māori in Fiordland. Accounts of New Zealand from the crew of the Resolution soon attracted the interest of sealers and whalers, and the first European sealing gang was put down in Luncheon Cove, Anchor Island in 1792 (Department of Conservation 2007), beginning an industry that was to almost completely annihilate fur seals from New Zealand shores. This party set about constructing the first European dwelling and vessel in New Zealand. Sealing camps were also present on Resolution Island and at Cascade Cove (Appendix 1) (Department of Conservation 2007). The first European shipwreck, the Endeavour, followed in Facile Harbour in 1795, and the first European woman to visit New Zealand was on board.

Introduction of game species in the late 1800s and early 1900s was a means of encouraging recreation and attracting tourists - intended to be a major income source for the fledgling nation - but had significant ecological impacts on indigenous vegetation and fauna. To help preserve natural values, all of the large islands and many of the smaller islands on the Fiordland coast were set aside as reserves, beginning with Resolution Island in 1891; the first flora and fauna reserve in New Zealand. In 1894, Richard Henry was appointed as New Zealand's first Government Ranger of Crown Lands, and curator of Resolution Island. He lived on Pigeon Island from 1894 until 1908 and attempted to protect indigenous bird populations by

undertaking transfers of birds from the mainland to Resolution Island. This was pioneering work in wildlife conservation even in an international context, and it made a great contribution to our knowledge of species such as kakapo.

Fiordland National Park was established in the early 1950s and has been accorded international recognition by its inclusion on the 'World Heritage' list, as established by the World Heritage Convention under the auspices of UNESCO. It forms part of the Te Wāhipounamu South West New Zealand World Heritage Area (Department of Conservation 2007).

Current human activities in the Dusky Sound area include commercial fishing, recreational fishing, tourism (including cruise ships), tramping, kayaking, and hunting. The historic site associated with Captain Cook's visit is the key visitor attraction in the project area. Richard Henry's house site on Pigeon Island and Astronomer Point have international significance as historic sites, while Luncheon Cove is nationally important (Department of Conservation 2007).

Previous draft restoration plans have been prepared for Resolution Island (Wickes and Edge 2012) and Anchor Island (Department of Conservation 2002), but an integrated restoration plan for the entire Dusky Sound project area is now required by the Department of Conservation, to avoid duplication and better integrate conservation objectives. Key requirements of the restoration plan are a strategic assessment of where to put conservation effort, and why. Conservation objectives are also required to be established in short-, medium-, and long-term priority frameworks.

The area covered by the restoration plan is not fixed but includes all of the terrestrial and marine ecosystems within Dusky Sound, Breaksea Sound, Wet Jacket Arm, and Acheron Passage, including any necessary 'buffer zones' on the mainland to enhance the protection of established or proposed pest control areas (Figure 1).

2. VISION

Dusky Sound is recognised internationally as one of the most intact ecosystems on Earth. Its lush rainforest, deep fiords, and numerous islands are teeming with wildlife. By day, bird-song rings out across the fiords, lizards and seals bask on shoreline rocks and dolphins forage in the deep water. At night, coastal forests teem with returning seabirds, while mountain valleys echo with the boom of kakapo and screech of kiwi. This is the Dusky Sound that Cook experienced when he rested here in 1772. It is an inspiration for biodiversity conservation across the world.

3. RATIONALE FOR SELECTION OF THE PROJECT AREA

Rats (*Rattus* spp.) and possums (*Trichosurus vulpeculus*) are absent from the 20,860 ha Resolution Island, which supports a wide range of habitats from exposed coastal herbfield to alpine grassland, several forest types, and many lakes and streams. These features, and the extensive area of potentially pest-free habitats, give Resolution Island a key strategic value for ecological restoration, if the key pest

Figure 1: Statutory context and management status of Dusky Sounds Islands

species, particularly stoats (*Mustela erminea*) and red deer (*Cervus elaphus scoticus*), can be eradicated or controlled to low levels. A large number of smaller islands surround Resolution Island and would both add value to restoration on Resolution Island (by providing a buffer), and be significant conservation units in their own right, if they too could be managed as largely-pest-free islands. Already, Anchor Island (1,136 ha), Breaksea Island (152 ha) and Hawea Island (8 ha) are pest-mammal free, while Cooper Island (1,778 ha), Long Island (1,899 ha), and Indian Island (167 ha) are possum-free. Pest control in buffer zones on the mainland would likely be required to maintain the pest-free and semi-pest free status of these islands, and would also help to maintain vegetation health and indigenous species populations on the mainland.

The project area contains two marine reserves established in 2005, encompassing a wide range of habitats. Taumoana/Five Fingers Marine Reserve (1,466 ha) contains shallow regions and large stretches of estuarine habitat around Five Fingers Peninsula, Cormorant Cove and Facile Harbour. Due to the low lying hillsides around the reserve the whole region is exposed to direct sunlight. Taumoana Marine Reserve also contains some of the only wave-exposed kelp forest habitat that is protected in the Fiordland Marine Area and is the only reserve with potential to hold significant populations of paua (*Haliotis iris*). These kelp forests are an important habitat and food source for both exploited and iconic fish and invertebrate species including blue cod (*Parapercis colias*), kina (*Evechinus chloroticus*), paua and rock lobster (*Jasus edwardsii*). Since its establishment, there have been significant increases in abundance of rock lobsters within the reserve. The reserve borders and encompasses islands, including the historically significant Pigeon Island, which potentially provide key habitat for nesting seabirds. This linkage provides a strategic opportunity to conserve land-sea interactions, including nutrient delivery from marine to terrestrial habitats by nesting seabirds and carbon flow from restored forests into protected marine food webs. Removal of terrestrial pests and regeneration of indigenous flora may also reduce the frequency of coastal landslips, which can damage fragile marine invertebrates including brachiopods and corals. The 2,007 ha Moana Uta (Wet Jacket Arm) Marine Reserve includes significant expanses of rock wall, broken rocky reef, deep basin, and estuarine habitat, which harbours intact populations of fragile encrusting invertebrates including high densities of black corals and brachiopods. The high diversity of these communities is of national and international significance. Since establishment, significant increases in both blue cod and rock lobster have been observed in the reserve and indirect or knock-on effects of fisheries closures are beginning to be seen in non-target species including a reduction in kina density and reestablishment of kelp forests in kina barrens (Wing and Jack 2010).

In total, approximately 1,500 ha of island habitats are free of pest animals, while another 25,000 ha have reduced pest assemblages, especially Resolution Island which is free from possums and rats. This is a significant conservation resource in itself, purely because of these reduced pest densities. When those islands have an intact primary indigenous vegetation cover, a wide availability of habitats, and direct linkages to marine protected areas, considerable strategic weight is added to any conservation activities undertaken in the Dusky Sound project area, and the full range of natural ecosystem functions is easier to restore.

4. DUSKY SOUND PROJECT AREA

4.1 Statutory and management context

Most of the project area lies within part of the 1,260,288 ha Fiordland National Park, which covers all terrestrial habitats within the project area. Breaksea Island is classified as a specially protected area within the Park (Figure 1). Marine habitats within the project area lie within the Fiordland Marine Area (FMA).

Management of Fiordland National Park is governed by the Fiordland National Park Management Plan (FNP Plan) under the National Parks Act 1980, and the Mainland Southland-West Otago Conservation Management Strategy (CMS) under the Conservation Act 1987. The CMS established initial island classifications which have subsequently been updated in the FNP Plan. The current management classification of the major islands is presented in Table 1. The islands in the project area fall into three categories: refuge islands, which are primarily for protection of their existing indigenous biodiversity, restoration islands, which are primarily for the recovery of threatened species populations, and open sanctuary islands, which are for both protection and restoration and public interpretation of conservation (Figure 1). The objectives of the Dusky Sound conservation and restoration plan are generally consistent with the objectives of the FNP Management Plan. Eradication of animal and plant pests from islands is supported where possible and practical, and control is supported if eradication is not feasible but indigenous biodiversity values justify protection.

In 1995, concern for the sustainability of Fiordland's commercial and recreational fisheries lead to the drafting of the Fiordland Conservation Strategy (2004), which was legislated as the Fiordland (Te Moana o Atawhenua) Marine Management Act 2005 (FMMA). The FMMA closed the inner regions of eleven fiords to commercial fishing (46,002.18 ha; 59% of the FMA) and established a network of eight new marine reserves nested within the commercial exclusion zones, bringing the total number of no-take areas to ten, and covering 10,421 ha or 13.11% of the FMA. This network of marine protected areas is an international showcase for spatial management of marine resources, in particular because marine reserve boundaries are adjacent to protected terrestrial habitats in Fiordland National Park. This provides a rare opportunity to conserve the interactions between conserved marine and terrestrial ecosystems.

Four government agencies work to manage components of the FMA. The Ministry for Primary Industries (MPI), Ministry for the Environment, Environment Southland, and Department of Conservation all contribute towards developing and implementing a Biosecurity Plan. The Ministry for the Environment and Environment Southland assist in biosecurity management and have developed a communication plan. Environment Southland governs the marine parts of Fiordland and is the statutory authority for resource consent applications in the marine area, including applications for coastal surface water activities. MPI Fisheries is responsible for developing a compliance plan to inform and educate fishers on fisheries regulations and to provide surveillance and prosecution capabilities. Finally the Department of Conservation is responsible for developing a monitoring plan to assess the effectiveness of the new management regime, and is also responsible for managing marine mammals, marine

reserves, and some commercial concessions relating to tourism. Under the FMMA, a group of representative stakeholders, the Fiordland Marine Guardians ("the Guardians"), were appointed by the Ministry for the Environment to advise on and manage issues relating to the FMA.

The inner waters of Dusky Sound and Breaksea Sound are closed to commercial fishing. In Moana Uta (Wet Jacket Arm) Marine Reserve and Taumoana (Five Fingers Peninsula) Marine Reserve, all extractive or destructive activities are prohibited. There are two no-anchoring zones or 'China Shops' to protect fragile encrusting organisms; one in Acheron Passage and another in Nine Fathoms Passage.

The Department is currently building a set of national conservation tools and standards, collectively called the Natural Heritage Management System (NHMS). NHMS includes tools for priority-setting (identifying where conservation work will be most effective at preventing extinctions and protecting the full range of ecosystems) and has also developed a national approach to biodiversity monitoring. Resolution Island, Anchor Island, and Indian Island are within the 50 top-ranked ecosystem management units (EMUs) defined to date. Resolution Island was selected as a representative part of western Fiordland, where the current stoat and deer control work in conjunction with the absence of possums were key factors promoting it as a priority EMU under NHMS. Anchor Island and Indian Island were selected within another high priority EMU, due to their pest-free status and presence of Threatened species. Long Island is not part of either EMU, but does serve as a buffer against pest reinvasion of Indian and Anchor Islands.

The biodiversity monitoring approach includes Tier 1 monitoring at a national scale, Tier 2 monitoring to assess the outcomes of conservation activities, and Tier 3 monitoring for intensive research purposes. Tier 1 monitoring plots are already present in the project area and the data from these plots may be useful at a broad level for assessing the responses of conservation activities undertaken as part of the Dusky Sound restoration project (e.g. dispersal of translocated bird populations, regrowth of palatable tree species). Where more specific monitoring is required (e.g. to determine population sizes or vegetation responses across a wider area), monitoring should be undertaken in accordance with national standards for Tier 2 monitoring.

Recovery plans exist for many of the threatened taxa present in the Dusky Sound project area, and for threatened taxa that could be translocated to Dusky Sound islands. Management objectives for translocated species need to be consistent with recovery plan objectives, and translocation applications require a consultative process with recovery groups and iwi.

The Deed of Settlement between the Crown and Ngāi Tahu 1997 and the Ngāi Tahu Claims Settlement Act 1998 placed a number of significant obligations on the Department of Conservation with respect to management of Fiordland National Park, including processes for consultation with Ngāi Tahu on management of taonga (treasured) species, many of which are relevant to the Dusky Sound restoration project.

Table 1: Management status (Department of Conservation 2007) of major islands and island groups in the Dusky Sound project area. *East Point Island refers to the unnamed island at the east end of Long Island.

Island/Island Group	Area (ha)	Management Status
Anchor Island	1,137	Restoration
Breaksea Islands	156	Refuge
Cooper Island	1,779	Open Sanctuary
Crayfish Island	9	Open Sanctuary
Curlew Island	12	Open Sanctuary
East Point Island*	45	Open Sanctuary
Entry Island	38	Refuge
Girlies Island	17	Open Sanctuary
Harbour Islands	48	Open Sanctuary
Heron Island	6	Open Sanctuary
Indian Island	168	Open Sanctuary
Inner Gilbert Islands	56	Open Sanctuary
John Islands	58	Open Sanctuary
Long Island	1,899	Open Sanctuary
Many Islands	32	Restoration
Nomans Island	20	Restoration
Oke Island	35	Open Sanctuary
Outer Gilbert Islands	11	Refuge
Parrot Island	40	Open Sanctuary
Passage Islands	18	Restoration
Petrel Islands	28	Open Sanctuary
Pigeon Island	73	Open Sanctuary
Prove Island	8	Restoration
Resolution Island	20,887	Restoration
Seal Islands	29	Restoration
Stop Island	10	Restoration
Thrum Cap	4	Restoration
Useless Islands	3	Open Sanctuary

4.2 Commercial and recreational use

Commercial and recreational use of Dusky Sound and Breaksea Sound comprises scenic cruises with guided walks ashore at historic sites, private chartered boats, private vessels, kayaking day use, kayaking overnight trips, fishing vessels, chartered helicopters and float planes for recreational hunting and scenic flights, cruise ships, and guided walks and private walkers on the Dusky Track. Key recreational sites are Supper Cove/Dusky Track, Richard Henry's house site, Luncheon Cove and track to Lake Kirirua, and Astronomers Point.

The Dusky Sound project area lies within a 'Remote' visitor setting, as defined in the Fiordland National Park Management Plan. This setting defines the required management of facilities and visitor numbers/patterns of use, and specifies minimum development of recreational facilities. There are limits to the amount of use at certain sites, for example maximum group sizes, total number of groups per day, and the total number of visitors per year for historic sites. There are also limits on the number of helicopter and float plane landings, hut capacities, boat capacities, group sizes, and trip frequencies.

The Dusky Track is walked by about 500 visitors per year, most of whom visit the track during the summer period.

4.3 Community and business involvement/support

Sponsors and community partners have played a strong role in the restoration of Dusky Sound since 2004, enabling restoration programmes to extend beyond Department of Conservation's core work programme. In 2007, the Fiordland Conservation Trust, a community-driven initiative, was established to provide independent funding and resources to support conservation projects in Fiordland, Southland and New Zealand's sub-Antarctic Islands. Since its establishment, the Fiordland Conservation Trust has been a partner in most of the sponsor projects contributing to Dusky Sound restoration, often taking the primary role of managing the relationship with the sponsor and seeking additional contributors to a specific project.

Working in partnership with sponsors has allowed animal pests to removed from selected smaller islands (i.e. Pigeon Island and Indian Island), and threatened species to be translocated to restoration islands (e.g. mohua (*Mohoua ochrocephala*) to Resolution Island, robins to Indian Island, mohua and South Island robins (*Petroica australis australis*) to Pigeon Island, rock wren (*Xenicus gilviventris*) to Anchor Island). Some of these sponsors are businesses which had an existing relationship with the Dusky Sound area and approached the Department seeking opportunities for biodiversity projects that they could contribute to.

Other sponsors have wanted to support a recovery programme for a specific taxon (e.g. mohua protection) or had a more general desire to support conservation programmes, which has been directed to priority projects in Dusky Sound (e.g. rock wren and mohua translocations).

There is also considerable support provided to conservation in Dusky Sound from 'in kind' contributions by local businesses, e.g. transport operators providing free or discounted travel. One example is that many businesses and volunteers are involved in the annual Fiordland Coastal Clean Up, which includes Dusky Sound and is led by local users of the Fiordland coast.

Volunteers have contributed considerable time to either community/sponsorship-led projects or Department of Conservation-led projects in Dusky Sound, including pest control, species translocations, and monitoring of project outcomes.

The Otago University/Whale and Dolphin Trust also partner with Department of Conservation for monitoring of dolphins in Dusky Sound as part of an ongoing joint research project.

4.4 Climate

The project area is mostly located within the Doubtful Ecological District, but the mainland on the southern side of Cook Channel lies within the Preservation Ecological District. The Doubtful Ecological District is noted for very high rainfall

(5,000-8,000 mm annually), and is generally cloudy, windy, and cool (McEwen 1987).

4.5 Geology

Several major faults are present within the project area. The Five Fingers Fault and Two Fingers Fault separate the Five Fingers Peninsula from the remainder of Resolution Island. These faults are active subsidiaries of the Alpine Fault which lies offshore. There is also a major fault on the eastern side of Resolution Island that separates the Mt Forbes-Mt Clerke area from the western part of the island. The major Dusky Fault runs along the southern side of Dusky Sound before turning southwest through Cascade Cove. There are several other south-west trending faults that cut across the mainland ridges between Breaksea Sound and Dusky Sound before merging with the Dusky Fault.

Most of Fiordland, including the Dusky Sound project area, is underlain by plutonic, mostly granitoid rocks of the Median Batholith, which were intruded into older metamorphosed sedimentary rocks (from the Takaka Terrane in the project area; Turnbull *et al.* 2010). Several plutonic formations are present in the Dusky Sound project area, dating from successive episodes of intrusive activity related to terrain amalgamation, continental thickening, and subduction along the Alpine Fault (Allibone *et al*. 2007). Takaka Terrane metasedimentary rocks are present in the central and southeastern parts of Resolution Island, the northern part of the Five Fingers Peninsula, on Long Island and Cooper Island, and in a band stretching from Wet Jacket Arm to Vancouver Arm (Figure 2; Turnbull *et al.* 2010). They are also present as smaller rafts on Anchor Island. There is an unusual occurrence of fossiliferous mudstone on the southeastern shore of Five Fingers Peninsula with thin coal seams present (Turnbull and Lindqvist 1981). Ledgard *et al.* (2008) report a marble outcrop and associated sinkholes near Mt Wales on Resolution Island.

4.6 Topography

The project area comprises the marine environment, glacier-carved fiords, islands, and the mountains and valleys of the mainland and larger islands. The distinct shape and topography of the Five Fingers Peninsula results from relatively young (Pliocene to Pleistocene; 1.5-3Ma) marine upthrust benches being forced up between the Alpine Fault offshore and the Five Fingers Fault system running up the inshore side of the peninsula (Turnbull *et al.* 2010).

The coastline is generally steep, rocky, and exposed. The coast is broken by the entrances to Breaksea Sound in the north and Dusky Sound in the south. The inner fiords form an ‘E’ with Breaksea Sound forming the top arm, Wet Jacket Arm the middle arm, Dusky Sound the lower arm, and the north-to-south running Acheron Passage the upright. Breaksea Sound forks into the Vancouver Arm and Broughton Arm at its head.

The fiords are full of coves and contain numerous islands and islets, the largest of which is Resolution Island (20,890 ha) which reaches 1,069 m asl. Other larger islands present include Long Island (1,900 ha, highpoint 620 m asl), Cooper Island

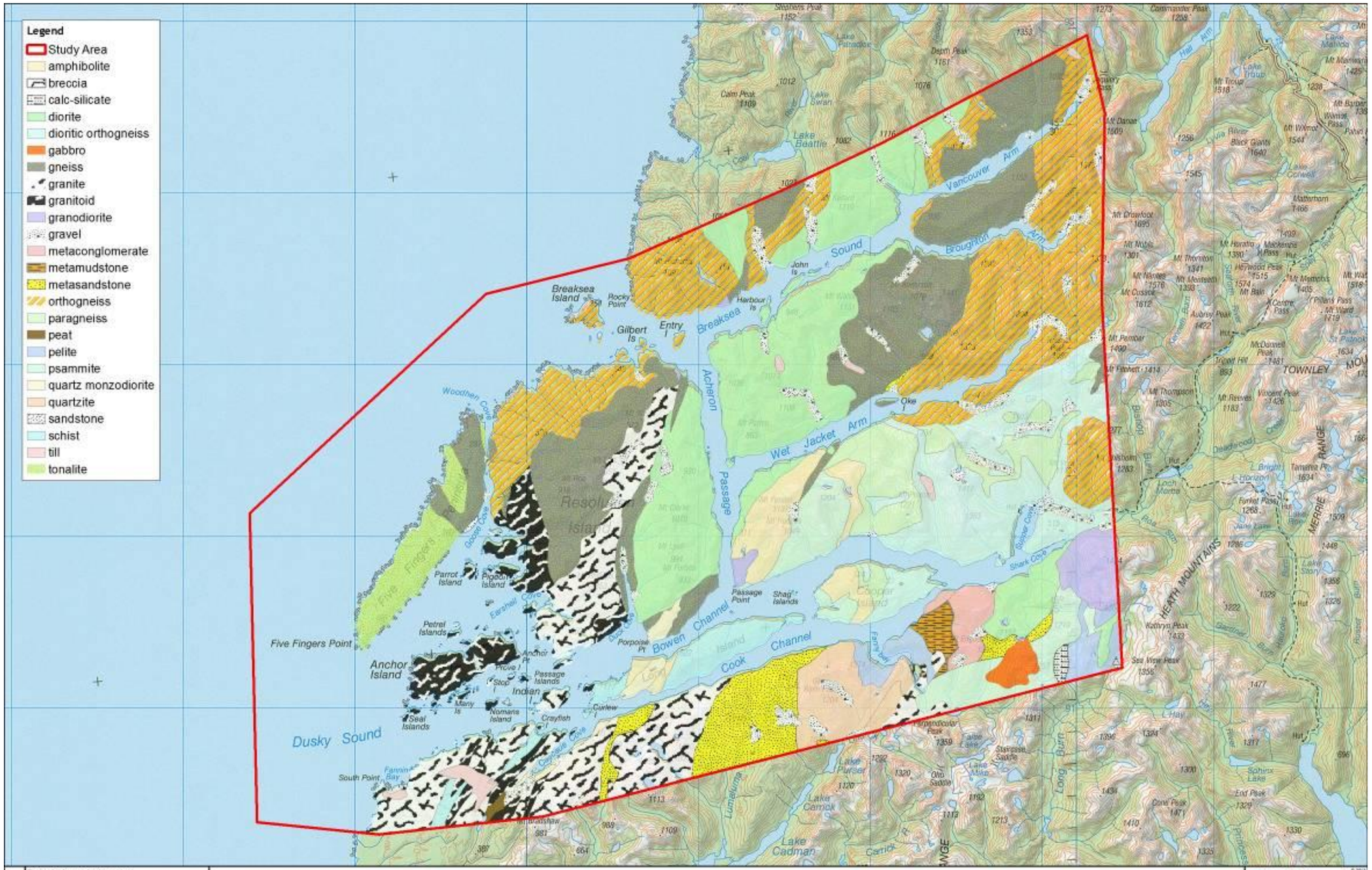


Figure 2: Geological map of the Dusky Sound area

(1,780 ha, highpoint 523 m asl), Anchor Island (1,140 ha, highpoint 417 m asl), Indian Island (167 ha, highpoint 189 m asl), Breaksea Island (153 ha, highpoint 350 m asl), and Pigeon Island (73 ha, highpoint 111 m asl). Of the remaining 703 smaller islands and islets, 11% are between 1 and 45 ha and 87% are less than 1 ha in size. Several of the larger islands contain lakes.

The mountain peaks on the mainland are generally between 1,000 and 1,500 m asl. The regional treeline lies at approximately 800-900 m asl, and therefore habitats within the project area extend from sea level to well into the alpine zone. Waterways on fiord/valley walls are steep, whilst those in glacially carved valleys are of moderate gradient. The largest waterway present is the Seaforth River flowing into Supper Cove at the head of Dusky Sound. Several lakes and tarns are present.

4.7 Soils

In general, the geological differences described above do not have an obvious influence on the vegetation pattern, with low-fertility soils being widespread due to the widespread distribution of plutonic rocks coupled with climatic factors (high rainfall and low temperatures) and recent glacial activity that has stripped soils in areas of glacially-smoothed topography.

The heads of many fiords comprise unconsolidated gravel, sand, and mud in recently-formed flood plains. Gravel and sand in active alluvial fans surround many steeper tributaries. There are small pockets of scree and colluvium, as well as unconsolidated, usually angular, boulder till in cirque moraines and tributary valleys (Turnbull *et al.* 2010). Landslides are widespread throughout Fiordland and the Dusky Sound project area is no exception to this pattern.

Gravel beach associations are uncommon with the only significant site being the gravel beach and bar in Disappointment Cove. One other minor gravel beach is present at the mouth of the largest river on the north coast of Resolution Island (Ledgard *et al.* 2008).

Salt marsh and estuarine systems consisting of marine sands and outwash silts and clays are present at the head of Woodhen/Goose Cove and Duck Cove on Resolution Island, and at the mouths of the larger rivers and stream that drain mainland sites within the project area.

Sandy recent soils characterised by dunes and alluvial outwash are present at the head of Woodhen Cove on Resolution Island. Deeper, more fertile alluvial and colluvial soils occur in valley floors and gully toeslopes. Soils on exposed coastal sites, for example the western coasts of the Five Fingers Peninsula and Resolution Island, are likely to be more productive due to low elevation, disturbance, and marine inputs.

Away from the coastal margin, soils vary with topography and elevation, and are generally acidic and podozolised or peaty (Ledgard *et al.* 2008).

Soils on steeper mountain slopes are mostly shallow, stony, very strongly leached and podzolised steepland soils. Areas of bare rock and sparsely-vegetated rock are common in the alpine zone throughout the project area, and are also present at lower

elevation where glacial activity has removed soil on topographic high points that have not received any subsequent soil inputs through erosional deposition.

4.8 Marine environment

Due to their distinct geomorphology, every New Zealand fiord is unique. However, the Dusky Sound project area comprises the largest and most interconnected complex of fiords and subsequently contains a diverse range of the representative habitats present in the Fiordland Marine Area. The complex is particularly representative of the southern fiords, which are characteristically broader at their entrances and contain many embayments and islands.

The New Zealand fiords are U-shaped drowned glacial valleys with a sill or lip separating them from the open ocean. Beneath the water surface, much of the fiords consist of near vertical cliffs with little surface relief in the upper 50 m. At the head of the fiords, shallow sandy areas are formed by river deltas or by hanging valleys spilling in from above (Stanton and Pickard 1981). The Fiordland marine environment is characterised by strong gradients in sunlight, wave action and salinity (Figures 3 and 4), both vertically through the water column and along the length of the fiord, from the tranquil inner fiord to the wave-washed open ocean (Goebel *et al.* 2005; Wing *et al.* 2007). Fiordland receives over 7 m of rainfall per year. Due to the steep topography and bush-clad coastline, this rainwater runs off into the fiords carrying with it forest detritus and humic material. This results in a brown-stained freshwater layer, which floats above the salt water and drives estuarine circulation as it flows out to sea (Gibbs 2000).

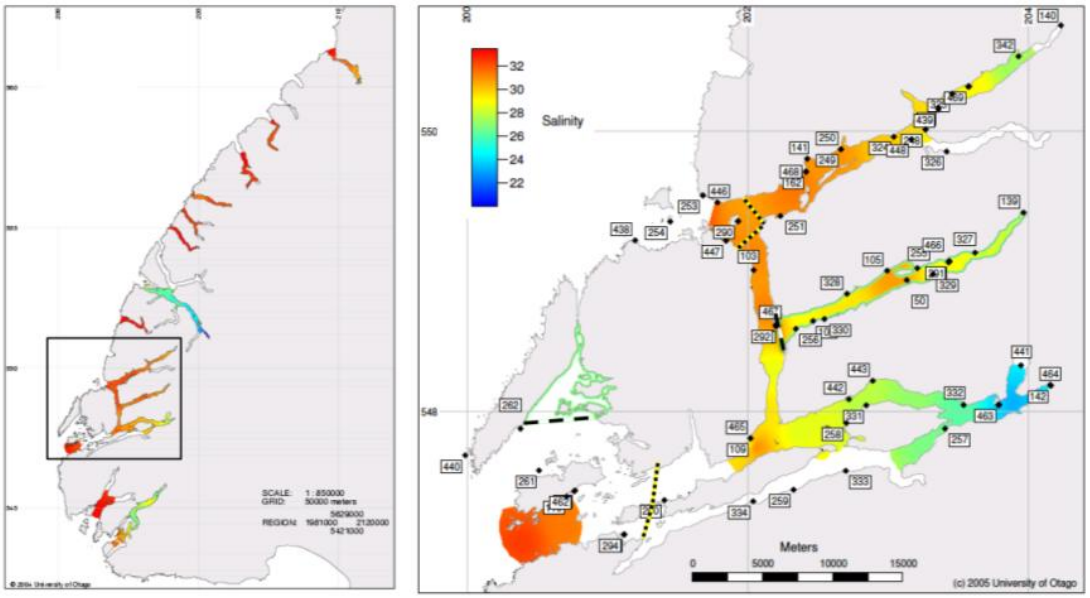


Figure 3: Salinity gradients within the Fiordland Marine Area (left) and Dusky Sound project area (right). Yellow-dashed lines demarcate inner-fiord commercial exclusion zones, while white-dashed lines show marine reserve boundaries.

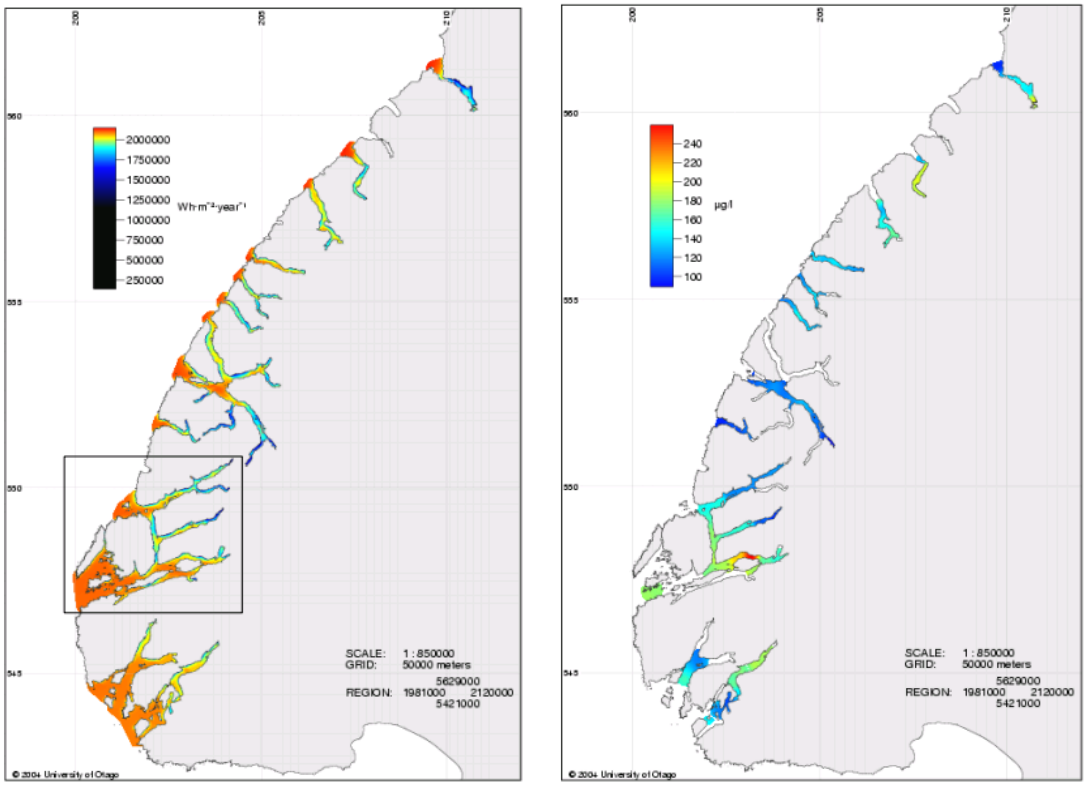


Figure 4: Solar radiation (left) and mean chlorophyll concentration (right) (an indicator of phytoplankton productivity) in the Dusky Sound project area and Fiordland Marine Area.

In the inner-fiord regions such as Breaksea Sound and Wet Jacket Arm, limited penetrance of waves from the open coast mean that the fresh water layer can be several meters deep (Figure 3; Wing *et al.* 2005). This thermohaline stratification in the water column is a driving force in controlling the structure of the subtidal communities (Witman and Grange 1998; Smith and Witman 1999; Willis *et al.* 2010; Wing and Jack 2010). The stained fresh water layer and shading due to the steep sided topography together limit light in the surface waters. This limits the growth of kelps and phytoplankton production in the inner fiord (Goebel 2001; Wing *et al.* 2007) and the rock walls are instead encrusted with filter feeding invertebrates normally present at much greater depths, including bryozoans, brachiopods and corals (Smith and Witman 1999). In the inner fiord, where primary productivity is reduced by the lack of light, a limited but critical amount of terrestrial material is also incorporated as an energy source into marine food webs (McLeod and Wing 2007; Wing *et al.* 2008; Jack *et al.* 2009; McLeod and Wing 2009; Wing *et al.* 2012) There is growing evidence that fishes and invertebrates including blue cod, sea perch (*Helicolenus percoides*), and kina are slower-growing in the inner fiord due to the lower productivity conditions compared to the outer fiord (Wing 2009; Beer *et al.* 2011; Beer and Wing 2013). There is also limited movement of animals between inner and outer fiord regions (Beentjes and Carbines 2005; Rodgers and Wing 2008; Beer *et al.* 2011).

Wave-washed outer coast regions, such as those on the seaward margins of Anchor Island, Five Finger Peninsula, and Breaksea Island, are exposed to the prevailing westerly winds. High irradiance and wave-driven mixing of the salt and fresh water

layers enable greater levels of primary productivity allowing forests of *Ecklonia radiata* and of bull kelp (*Durvillaea antarctica*) to establish (Wing and Jack 2007; 2010). These kelp forests provide an important habitat and food source for both commercially-exploited and iconic fish and invertebrate species, including blue cod, kina, paua and rock lobster. Greater phytoplankton productivity allows the establishment of intertidal bands of mussels (mostly blue mussels *Mytilus edulis galloprovincialis*, but also green lipped mussels *Perna canaliculus* and ribbed mussels *Aulacomya atra maoriana*) (Wing and Jack 2010). These mussels are food resources for higher trophic level omnivores, especially rock lobsters *(*Jack and Wing 2012), but also blue cod (Wing *et al.* 2012) and wrasses (*Notolabrus spp.*) (Davis and Wing 2012). The exposed open coast of Five Finger Peninsula is especially close to the continental shelf edge and productivity there may be enhanced by upwelling currents.

Primary productivity of phytoplankton in the Dusky Sound project area is high compared to other sites in Fiordland. The wide topography and open fiord morphology facilitate light and wave penetrance deep into the fiords. This wave action, in combination with high tidal flows around the many islands and headlands, drives mixing of the low salinity layer (which is high in silicic acid but low in nitrate and phosphate) with the underlying saline layer (low in silicic acid, higher in nitrate and phosphate), which results in the alleviation of nutrient limitation on phytoplankton productivity (Goebel *et al.* 2005). In general, phytoplankton productivity is highest in the semi-exposed mid-fiord regions, where sufficient levels of irradiation and mixing result in high productivity, but advection out of the basin is low and retention can enable biomass to accumulate as seasonal blooms (Figure 4). In the Dusky Sound complex, the open topography creates the potential for significant barotrophic forcing of flow through the Acheron Passage. This wave-driven flushing can bring pelagic productivity from the open ocean deep into the fiord basins.

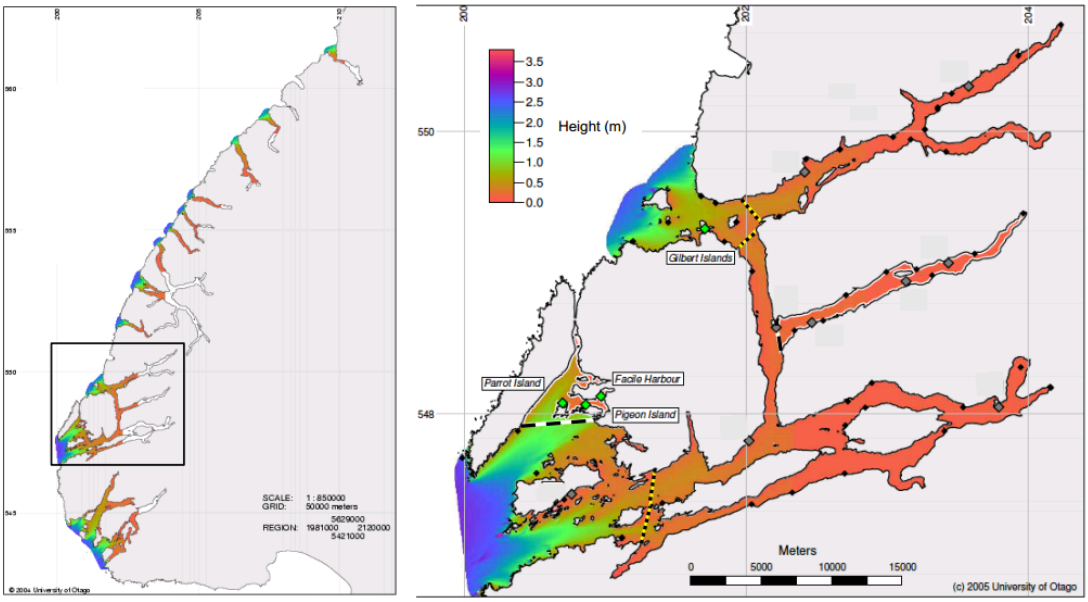


Figure 5: Modelled wave heights in the Fiordland Marine Area (left) and Dusky Sound project area (right). Dashed lines indicate commercial exclusion zones and marine reserve boundaries, as per Figure 3.

The gradient from inner- to outer-fiord habitat is controlled by the geomorphology of each fiord. The Dusky Sound complex is relatively wide, open and low-lying with

good wave penetrance from southwest swells so that the transition zone from kelp-dominated to invertebrate-dominated communities extends relatively far into the fiord compared to other fiords.

4.9 Terrestrial vegetation and flora

4.9.1 Vegetation and habitats

The steep lowlands lining the coast and fiords are covered in forest comprising combinations of podocarps (rimu with miro and Hall's totara), broadleaved species (kamahi and southern rata), and silver beech (*Nothofagus menziesii*). Silver beech forest dominates at higher altitudes, apart from on thin soils which carry mountain beech (*N. solandri* var. *cliffortioides*). Subalpine scrub at the treeline gives way to alpine tussock grassland dominated by *Chionochloa crassiuscula* or *C. acicularis* in poorly-drained and infertile sites, and mid-ribbed snow tussock (*C. pallens* subsp. *cadens*) and/or narrow-leaved snow tussock (*C. rigida* subsp. *amara*) on better-drained and more fertile alpine sites. Manuka and *Chionochloa acicularis* are locally dominant mostly on peat in poorly-drained lowland habitats on Resolution Island and on the mainland to the south. Scrub on exposed coastal sites on the western margin of Resolution Island is dominated by inaka (*Dracophyllum longifolium*) and *Olearia oporina*, with *Hebe elliptica* and whaririki (*Phormium cookianum*) at lower abundances. This gives way to coastal herbfield, where exposure to salt spray is even greater.

A vegetation survey of Resolution Island (Ledgard *et al.* 2008; Table 2) provides a useful summary of typical vegetation types in the project area, lacking only the full expression of alpine habitats present on mountains >900 m (Table 1). Breaksea Island (Allen *et al.* 1990) and Hawea Island (Taylor and Thomas 1989) have vegetation communities that are analogous to several of those on Resolution Island, but have much fewer vegetation communities overall due to their smaller size and lack of alpine habitats. Anchor Island is primarily vegetated in rimu-southern rata forest and low stature forest in which yellow silver pine is prominent, and has wet clearings that are vegetated in wetland and scrub associations similar to those present in poorly-drained habitats on Resolution Island (Rance 2002).

Table 2: Vegetation communities on Resolution Island (from Ledgard *et al*. 2008).

Bioclimatic Zone	Vegetation Community	Composition	Distribution	Altitude (m asl)
Alpine	*Chionochloa acicularis* tussockland	*Chinochloa acicularis*, *Celmisia* spp., *Carpha alpina* and other associated species	Alpine tops	>700
	Chionochloa pallens and *C. rigida* subsp. *amara* tussockland	*Chinochloa pallens*, *Hebe odora* and *Dracophyllum* spp. dominated tussock-shrubland	Alpine tops	>800
	Fell field, exposed rock turf communities	Set amongst rocky crags, scree and exposed granite domes. Low vegetation cover with prostrate shrub and plant communities	Mt Lort	>550
	Exposed cliff community	Steep, moist cliff face characterised by a mosaic of shrub species such as moss, *Epilobium*, *Gaultheria*, and *Bulbinella* spp.	Western range	>600

Bioclimatic Zone	Vegetation Community	Composition	Distribution	Altitude (m asl)
	Tussock dominated shrub community	*Chionochloa acicularis* interspersed with *Dracophyllum* spp., flax, and *Hebe* spp.	Alpine tops	700-900
Shrubland	Mixed indigenous scrub - subalpine	*Dracophyllum* spp., pink pine, *Olearia* spp., *Hebe* spp., flax grading to subalpine forest	Adjacent to or amongst alpine grassland	500-700
	Infertile podocarp-broadleaved scrub	Manuka, pink pine and yellow silver pine dominated scrub/stunted forest	Infertile sites around the island	200-600
	Leptospermum scrub dominated shrubland	Manuka dominated shrubland	Exposed bedrock ridges and swamps	200-700
	Mixed indigenous scrub - coastal	Coastal scrub belt and rocky shore - *Olearia* spp., *Dracophyllum longifolium*, *Hebe* spp., flax, three finger	Steep coastal fringes, exposed sites	5-40
Forest	Highland podocarp-broadleaved-beech forest	Silver/mountain beech, pink pine canopy over a broadleaved shrub under story	Sub alpine stunted forests throughout	500-600
	Lowland podocarp-broadleaved-beech forest, infertile	Rata/silver pine/kamahi/beech/rimu over a mingimingi, yellow silver pine, *Coprosma* spp. understorey	Mid - low altitude infertile	100-300
	Lowland podocarp-broadleaved-beech forest, fertile	Silver beech, kamahi, miro, rimu over palatable broadleaved understorey, fern forest floor	Mid - low altitude fertile	5-200
	Broadleaved forest	A variety of broadleaved shrub-tree species with the noticeable absence of beech and podocarps	Woodhen Cove isthmus	11
	Beech forest	Beech dominated subalpine forest - >85% silver or mountain beech over a sparse understorey	Eastern faces above Acheron Passage	500-800
	Beech broadleaved forest	Beech/kamahi/rata dominated forest with broadleaf understorey over fern	Mid slope - mid altitude	20-600
Coastal	Dune land with tidal fan	Combination of salt marsh, turf and dune species	Head of Goose Cove	<5
	Rocky shoreline vegetation	Characterised by matt species amongst rocks such as *Isolepis praetextata* and other short coastal species such as *Blechnum banksii* and *Poa breviglumis* and *P. astonii*.	North coast and Five Fingers Peninsula Shoreline	<5
	Beach/Rivermouth	*Carex* spp., *Poa* spp. and *Coprosma* spp. shrubs - weedy. Variable in composition and rare in occurrence.	Uncommon - North coast and Goose Cove	1
Wetland	Lake margin/wetland	Dominated by rushes and sedges and freshwater aquatics such as *Potamogeton* spp.	Uncommon	600
	Cushion bog	Characterised by *Donatia novae-zelandiae*, *Drosera* spp., *Oreobolus* spp., and other cushion bog species	Mt Roa, Five Fingers Peninsula	600-850
	Manuka wetland	Ecotone between bog areas and forest - manuka interspersed with stunted infertile forest spp. such as pink pine and mountain beech.	On the margins of valley floor bogs	100-650

Bioclimatic Zone	Vegetation Community	Composition	Distribution	Altitude (m asl)
	Lowland-montane wetland	Mixture of *Chionochloa acicularis* with moss interspersed with other wetland monocots	Poorly drained inter-montane basins and valley floors, Five Fingers Peninsula	50-700
Other	River banks	Varied depending on substrate and species rich - very diverse	Island wide	20-200
	Slip/regenerating bush	Regenerating broadleaf species and herbs amongst crown fern, heavily browsed	Exposed steep faces and windswept ridges	400-100
	Marble outcrop	Localised outcrop of marble with species that prefer higher fertility situations than the surrounding landscape exhibited: Fuchsia, pate and ribbonwood	East of Mt Wales	498

4.9.1 Originally rare ecosystems

A number of originally rare ecosystems occurs within the project area, most of which are Threatened (Holdaway *et al.* 2012). They are mainly associated with coastal habitats (Table 3). This highlights the need to enhance interactions between terrestrial and marine ecosystems.

Table 3: Originally rare ecosystems (Williams *et al*. 2007) present within the Dusky Sound project area. Threat classifications are from Holdaway *et al*. (2012).

Category	Common Name	Threat Classification
Inland	Calcareous cliffs, scarps, and tors	Vulnerable
Coastal	Stable sand dune	Endangered
	Estuaries	Vulnerable
	Shingle beaches	Endangered
	Coastal rock stacks	
	Coastal turfs	Critically Endangered
Induced by indigenous vertebrates	Seabird burrowed soils	Critically Endangered
	Marine mammal haulouts	Critically Endangered
Wetlands	Lake margins	Vulnerable
	Cushion bog	
	Seepages and flushes	Endangered

4.9.2 Threatened, At Risk, and other notable plant species

Seventeen nationally At Risk plant species have been recorded from the project area (Table 4). In addition, Dusky Sound is the type locality for several indigenous plant species.

Table 4: Notable indigenous vascular plant species recorded on Resolution Island (Ledgard *et al*. 2008), Breaksea Island (Allen *et al*. 1990), and Anchor Island (Rance 2002). Threat classifications are from de Lange *et al*. (in press).

Threat Classification	Species	Common Name	Notes
Threatened-Nationally Critical	*Sticherus tener*		Resolution and Anchor Islands are the main New Zealand site for this species, also present in North Westland.
At Risk-Declining	*Carex littorosa*		Recorded from Duck Creek, Disappointment Cove and Goose/Woodhen Cove.
	Alepis flavida	Yellow-flowered mistletoe	Low numbers recorded from several scattered sites.
	Ficinia spiralis	Pingao	Only recorded from Disappointment Cove, where it is uncommon.
	Myriophyllum robustum	Giant milfoil	Lake Forster (Cascade Cove)
	Peraxilla colensoi	Scarlet mistletoe	Low numbers recorded from a few scattered sites.
	Peraxilla tetrapetala	Red mistletoe	Low numbers recorded from a few scattered sites.
	Sonchus kirkii	Native sow thistle	Disappointment Cove, Five Fingers Peninsula, and Breaksea Island.
At Risk-Naturally Uncommon	*Abrotanella muscosa*		Recorded locally from Mt Roa from within moss on wet rock.
	Anisotome lyallii		Recorded from coastal habitat.
	Brachyglottis bifistulosa		Very localised.
	Carex pleiostachys		Recorded from coastal habitat.
	Crassula helmsii		Recorded locally from saltmarsh areas.
	Drymoanthus flavus		Forest on Anchor Island
	Gentianella lineata		Recorded from alpine bogs.
	Grammitis rigida		Recorded from coastal rocks.
	Myosotis rakiura		Recorded from coastal habitat.
	Myosotis spathulata		Very localised.
	Sprengelia incarnata		Recorded from lowland bogs.
	Uncinia viridis		Recorded from alpine tussockland.
Not Threatened	*Celmisia holosericera*		Fiordland endemic.
	Corybas cheesemanii		Uncommon in Southland
	Dracophyllum fiordense		Fiordland endemic.
	Drymoanthus adversus		This species is uncommon in Southland and is probably impacted by possum browsing.

4.10 Terrestrial fauna

4.10.1 Bats

Limited surveys have taken place to determine whether bats are present within the Dusky Sound project area. A two-week survey was undertaken in the Dagg Sound Peninsula/Mt Forbes area in May/June 2011 (Hannah Edmonds, Department of Conservation, pers. comm.). These surveys took place in winter when bat activity levels are low (O'Donnell 2000) and therefore the probability of detection of bats was low. Neither the Nationally Endangered short-tailed bat (southern lesser short-tailed bat, *Mystacina tuberculata tuberculata*) nor the Nationally Critical long-tailed bat (South Island long-tailed bat, *Chalinolobus tuberculatus*) were detected during the surveys. However, there are records of both species from Fiordland National Park. In

2000, long-tailed bats were recorded at West Arm, Lake Manapouri and are also present in Iris Burn and Freeman Burn. There is also an unconfirmed report of short-tailed bats from Iris Burn Valley (Hannah Edmonds, Department of Conservation, pers. comm.). It is possible that both species are present within the Dusky Sound project area in areas that are suitable for both foraging and roosting due to the presence of linear landscape features that long-tailed bats tend to forage along; forested areas that short-tailed bats tend to feed within; and large cavity-bearing trees, that both species select to roost within in other areas of Fiordland (O'Donnell *et al*. 1999; O'Donnell *et al*. 2006; Sedgeley and O'Donnell 1999).

4.10.2 Avifauna

Several species of birds were first described from specimens taken from Dusky Sound, including paradise shelduck (*Tadorna variegata*), New Zealand scaup (*Aythya novaeseelandiae*), grey duck (*Anas superciliosa superciliosa*), western weka (*Gallirallus australis australis*), kereru (*Hemiphaga novaeseelandiae*), brown creeper (*Mohoua novaeseelandiae*), South Island kaka (*Nestor meridionalis meridionalis*), yellow-crowned parakeet (*Cyanoramphus auriceps auriceps*), and South Island robin (OSNZ 2010). These records originate from Lieutenant James Cook's visit to Dusky Sound in 1773.

Terrestrial bird populations have been significantly affected by the introduction and spread of rodents and stoats. Since Cook's expedition, many species are no longer present in the project area, and some are extinct or close to extinction within New Zealand, including South Island snipe (*Coenocoryphya iredalei*), brown teal (*Anas chlorotis*), South Island kokako (*Callaeas cinerea*), and takahe (*Porphyrio hochstetteri*). Several of these near-extinct species, including shore plover (*Thinornis novaeseelandiae*), southern New Zealand dotterel (*Charadrius obscurus obscurus*), and kakapo (*Strigops habroptila*), were also first described from the area.

Burrowing seabirds would have once been common in Dusky Sound, nesting in areas with suitable soil depth and structure. Their populations are likely to have been severely affected by the introduction and spread of terrestrial predators. Mottled petrel (*Pterodroma inexpectata*), sooty shearwater (*Puffinus griseus*), and broad-billed prion (*Pachyptila vittata*) are known from a number of islands and island groups including Front Island, Shag Island, Breaksea Island, Anchor Island, Seal Island, the inner Gilbert Islands, and some outer islands in Dusky Sound (McEwen 1987; Te Anau Area Office staff, pers. comm.). Fiordland crested penguin (*Eudyptes pachyrhynchus*) breed on Indian Island, Pigeon Island, (see unknown island in Russ 1992; 22 nests), Breaksea Island, Entry Island, and Hawea Island (Russ *et al*. 1992; McLean *et al*. 1993). Southern blue penguins are widespread through the project area (McEwen 1987; Russ *et al*. 1992; McLean *et al*. 1993). Brown skua (*Catharacta skua lonnbergi*) breeds in Breaksea and Dusky Sound (Taylor & Thomas 1989). Historically, more species and a greater distribution and abundance of seabirds, would have been present within the project area.

Table 5: Avifauna recorded within the Dusky Sound project area. Species names and threat classifications are from Miskelly *et al*. (2008). Reintroduced species (e.g. kakapo) are included.

Threat Classification	Species	Common Name	OSNZ grid squares[1]	Hawea Island[2]	Indian Island	Resolution Island[3]
Threatened-Nationally Critical	*Anas superciliosa superciliosa*	Grey duck	●			
	Egretta alba modesta	White heron	●			
	Strigops habroptilus	Kakapo				
Threatened-Nationally Endangered	*Larus bulleri*	Black-billed gull	●			
	Falco novaeseelandiae "southern"	Southern falcon	●	●	●	●
	Nestor meridionalis meridionalis	South Island kaka	●		●	●
Threatened-Nationally Vulnerable	*Apteryx australis*	Southern Fiordland tokoeka	●		●	●
	Egretta sacra sacra	Reef heron	●		●	
	Diomedea antipodensis gibsoni	Gibson's albatross[4]	●			
	Eudyptes pachyrhynchus	Fiordland crested penguin	●	●	●	
	Hymenolaimus malachorhynchos	Blue duck; whio	●			
	Larus novaehollandiae scopulinus	Red-billed gull	●			●
	Mohoua ochrocephala	Yellowhead	●			
	Phalacrocorax varius varius	Pied shag	●			●
	Xenicus gilviventris	Rock wren	●			
At Risk-Declining	*Acanthisita chloris chloris*	South Island rifleman	●			●
	Anthus novaeseelandiae novaeseelandiae	New Zealand pipit	●			●
	Bowdleria punctata punctata	South Island fernbird; matata	●			●
	Diomedea cauta steadi	New Zealand white-capped mollymawk	●			
	Eudyptula minor minor	Southern blue penguin	●	●	●	
	Gallirallus australis australis	Western weka	●			
	Haematopus finschi	New Zealand pied oystercatcher[5]				●
	Procellaria aequinoctialis	White-chinned petrel	●			
	Puffinus griseus	Sooty shearwater	●	●	●	●
	Sterna striata	White-fronted tern	●			
At Risk-Recovering	*Philesturnus carunculatus*	South Island saddleback	●			

1 OSNZ records (1999-2004) for 22 1000×1000 m grid squares: 199/547-546, 200/549-546, 201/549-546, 202/550-547, 203/550-547, and 204/550-547 (Robertson *et al.* 2007).
2 Taylor and Thomas (1989).
3 Ledgard *et al.* (2011).
4 Gibson's, Antipodean, and snowy albatross are combined in the OSNZ atlas.
5 Largely absent from Fiordland according to the OSNZ atlas, but not easily confused with variable oystercatcher.

Threat Classification	Species	Common Name	OSNZ grid squares[1]	Hawea Island[2]	Indian Island	Resolution Island[3]
	Thalassarche cauta steadi	New Zealand white-capped mollymawk	●			
At Risk-Naturally Uncommon	*Catharacta skua lonnbergi*	Brown skua[1]	●	●		●
	Daption capense australe	Snares Cape pigeon[2]	●			
	Diomedea bulleri bulleri	Southern Buller's mollymawk	●			
	Diomedea antipodensis antipodensis	Antipodean albatross[3]	●			
	Diomedea epomophora spp.[4]	Royal albatross ssp.	●			
	Eudynamys taitensis	Long-tailed cuckoo	●			
	Nestor notabilis	Kea	●			●
	Phalacrocorax carbo novaehollandiae	Black shag	●			
	Phalacrocorax melanoleucos brevirostris	Little shag	●			
	Phalacrocorax sulcirostris	Little black shag	●		●	
	Procellaria westlandica	Westland petrel	●			
	Puffinus bulleri	Buller's shearwater	●			
	Thalassarche impavida	Campbell Island mollymawk[5]	●			
At Risk-Recovering	*Haematopus unicolor*	Variable oystercatcher	●		●	
At Risk-Relict	*Pachyptila turtur*	Fairy prion	●			
	Pachyptila vittata	Broad-billed prion		●		
	Pterodroma inexpectata	Mottled petrel	●			
Not Threatened	*Anthornis melanura melanura*	Bellbird	●	●	●	●
	Ardea novaehollandiae	White-faced heron	●			●
	Aythya novaeseelandiae	New Zealand scaup	●			
	Chrysococcyx lucidus lucidus	Shining cuckoo	●			●
	Cyanoramphus auriceps auriceps	Yellow-crowned parakeet	●		●	●[6]
	Cygnus atratus	Black swan[7]				
	Gerygone igata	Grey warbler	●	●	●	●
	Halcyon sancta vagans	New Zealand kingfisher	●			
	Hemiphaga novaeseelandiae	Kereru	●	●	●	●
	Larus dominicanus dominicanus	Southern black-backed gull	●		●	

[1] Taylor and Thomas (1989) refer to *Stercorarius parasticus* (Artic skua), but provide the common name of southern great skua (i.e. brown skua). Ledgard *et al.* 2011 refer to 'skua'. Both are likely to be brown skua.
[2] Cape pigeon and Snares Cape pigeon are combined in the OSNZ atlas due to identification problems at sea.
[3] Gibson's, Antipodean, and snowy albatross are combined in the OSNZ atlas.
[4] Southern and northern royal albatross are combined in the OSNZ atlas due to identification problems at sea. Both are At Risk-Naturally Uncommon.
[5] Campbell Island mollymawk and black-browed mollymawk combined in OSNZ atlas due to identification problems at sea.
[6] Recorded as "parakeet".
[7] Dr Lucy Jack pers. obs.

Threat Classification	Species	Common Name	OSNZ grid squares[1]	Hawea Island[2]	Indian Island	Resolution Island[3]
	Mohoua novaeseelandiae	Brown creeper	●		●	●
	Morus serrator	Australasian gannet	●			
	Ninox novaeseelandiae novaeseelandiae	Morepork	●			●
	Petroica australis australis	South Island robin	●			
	Petroica macrocephala macrocephala	Yellow-breasted tomtit	●	●	●	●
	Prosthemadera novaeseelandiae novaeseelandiae	Tui	●		●	
	Rhipidura fuliginosa fuliginosa	South Island fantail	●	●	●	●
	Stictocarbo punctatus punctatus.	Spotted shag	●			
	Tadorna variegata	Paradise shelduck	●		●	●
	Vanellus miles novaehollandiae	Spur-winged plover	●			
	Zosterops lateralis lateralis	Silvereye	●	●	●	●
Coloniser	*Thalassarche melanophrys*	Black-browed mollymawk[1]	●			
Migrant (indigenous)	*Daption capense capense*	Cape pigeon[2]	●			
	Diomedea exulans	Snowy albatross[3]	●			
	Macronectes giganteus	Southern giant petrel	●			
	Numenius madagascariensis	Far-eastern curlew	●			
Introduced and Naturalised	*Anas platyrhynchos*	Mallard	●			●
	Branta canadensis maxima	Canada goose	●			
	Carduelis carduelis	Goldfinch	●			
	Carduelis chloris	Greenfinch	●			●
	Carduelis flammea	Redpoll	●			
	Cygnus atratus	Black swan	●			
	Emberiza citrinella	Yellowhammer	●			
	Fringilla coelebs	Chaffinch	●	●	●	●
	Prunella modularis	Dunnock	●	●	●	
	Turdus merula	Blackbird	●	●	●	●
	Turdus philomelos	Song thrush	●	●	●	

[1] Campbell Island mollymawk and black-browed mollymawk combined in OSNZ atlas due to identification problems at sea.
[2] Cape pigeon and Snares Cape pigeon are combined in the OSNZ atlas due to identification problems at sea.
[3] Gibson's, Antipodean, and snowy albatross are combined in the OSNZ atlas.

Other seabird species may be present within the project area, but have not been detected. These include the At Risk-Relict common diving petrel (*Pelecanoides urinatrix*), fairy prion (*Pachyptila turtur*), grey-backed storm petrel (*Garrodia nereis*), and New Zealand white-faced storm petrel (*Pelagodroma marina maoriana*), which may be present on islands that have been historically pest-free.

'Important Bird Areas' (IBAs) is a BirdLife International initiative, aimed at identifying, monitoring and conserving the most important sites for the world's birds. Important areas for New Zealand seabirds are presently being compiled (Gaskin 2013). The current undertaking is the first step in developing a full catalogue of IBAs for New Zealand, and covers terrestrial seabird sites only. The draft boundaries of the 'Dusky Sound Wet Jacket Arm IBA (multiple sites)' covers a number of islands in the Dusky Sound project area, including Anchor Island, Indian Island, and Parrot Island, and the Seal Islands and Petrel Islands (Figure 6).

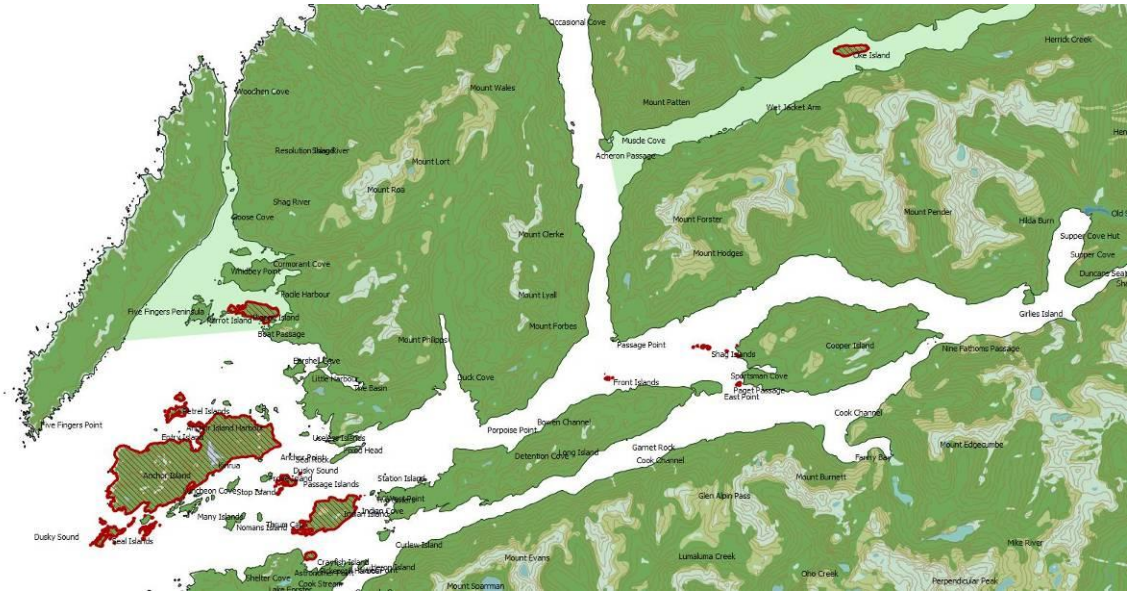


Figure 6: Dusky Sound Wet Jacket Arm Important Bird Area (multiple sites) - draft (from Gaskin 2013)

4.10.3 Herpetofauna

Skinks and geckos

The herpetofauna of the Dusky Sound project area are not well known due to a combination of the remoteness of the area, the challenging access, and the difficulties of surveying lizards in the heavily forested areas that are typical of the Doubtful Ecological District. However, since 2005, a plethora of new taxa have been found over the wider Fiordland area, generally in non-forested habitats, and no doubt more remain to be discovered, including within the Dusky Sound project area.

Fiordland skinks (*Oligosoma acrinasum*) are well known from Dusky Sound and occur on a handful of islands and island groups, including Entry Island, Seal Islands, Resolution Island, Gilbert Islands, Wairaki Island, Breaksea Island, and Hawea Island,

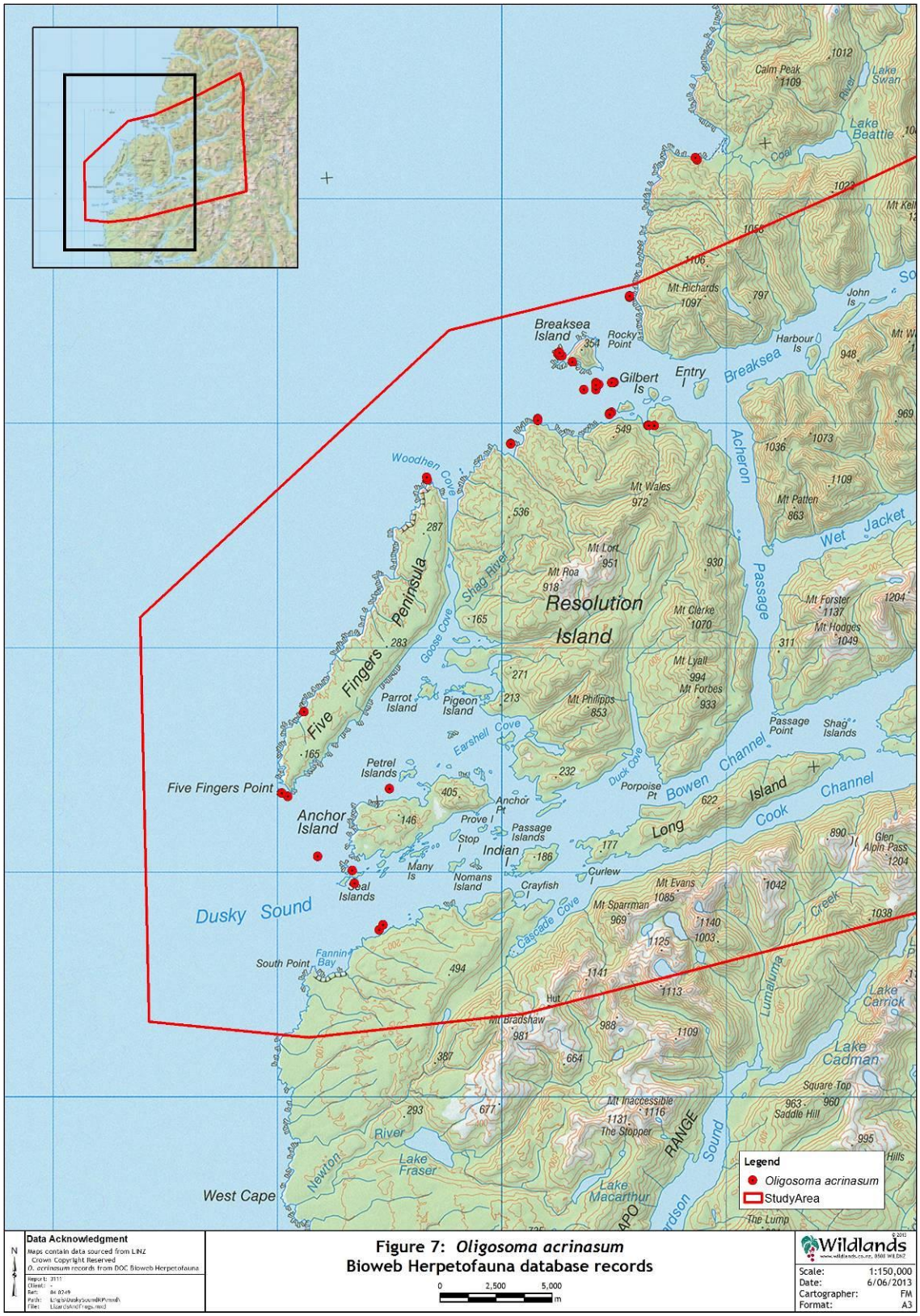
as well as on various unnamed islets (Department of Conservation Bioweb Herpetofauna database March 2013; Figure 7), and are likely to be present in several other coastal sites within the project area. The distribution of Fiordland skink is assumed to be relictual as it also occurs on a few mainland locations. Fiordland skinks have been translocated to Hawea Island (Thomas and Whitaker 1994) and the species naturally recolonised Breaksea Island from a stack 100 m offshore following eradication of Norway rats in 1988. The Regional Priority (Southland Conservancy) for Fiordland skink is "Low (Moderate)" (Roberts 1999) and the species has been classified as At Risk-Relict in the latest lizard threat classification (Hitchmough *et al*. in press). Populations of Fiordland skinks on Resolution Island are reported to be recovering (Hannah Edmonds pers. comm. to the Department of Conservation reptile threat panel 2012), presumably due to the control of stoats.

The "Threatened-Nationally Critical" Te Kakahu (Chalky Island) skink, *Oligosoma tekakahu* occurs only on Chalky Island (514 ha) in Preservation Inlet, south of the Dusky Sound project area (in Preservation Ecological District). This species can be viewed as indicative of the level of genetic divergence that may be expected in any lizard populations over the Dusky Sound project area within its *c*.700 islands, i.e. distinct, as yet undiscovered, genetic entities may also occur on Dusky Sound Islands.

There is a high probability that a green gecko (*Naultinus* sp.) occurs within the Dusky Sound project area. Any *Naultinus* from Dusky Sound is likely to be a distinct management unit of the jewelled gecko (*N. gemmeus*) based on recent genetic results indicating the "jewelled geckos" of the south are distinct from more northerly populations (Rod Hitchmough pers. comm. 2013). "Green gecko" records occur for Te Anau Downs and the Milford Sound area - but the specific identity of these specimens has not be yet been determined (Department of Conservation Herpetofauna Database). A member of the *Oligosoma chloronoton/lineoocellatum* species complex may also occur over the project area; this species complex is known from the Te Anau Basin (Roberts 1999). *Oligosoma inconspicuum*, Southlands "common skink" is also a good candidate for discovery over the project area, and given the patchy geographic spread over Fiordland of the genera *Mokopirirakau* and *Woodworthia*, populations of these species may also be present over the Dusky Sound Project Area. Should these predictions prove correct, large islands with more diverse habitats are likely to have the highest lizard-species richness, i.e. Resolution, Long, Cooper, Anchor, Indian, Breaksea and Pigeon Islands.

Frogs

No indigenous frogs are known to occur within the Dusky Sound project area. A large-bodied frog, *Leiopelma auroraensis* occurred in the area in pre-human times (Newman 1996), with the closest record to the project area being bones found in Aurora Cave, near Te Anau. The demise of this frog species is most likely to have been caused by repeated plagues of kiore that spread through southern forests in response to beech masting events (Newman 1996). Given the complexity of habitat on some of the larger Dusky Sound islands, there is a slim possibility that a species of *Leiopelma* may occur over the Dusky Sound project area, especially if deep rock tumbles occur in forested areas.


Legend
Oligosoma acrinasum
StudyArea
Data Acknowledgment
Maps contain data sourced from LINZ
Crown Copyright Reserved
O. acrinasum records from DOC Bioweb Herpetofauna
Figure 7: Oligosoma acrinasum
Bioweb Herpetofauna database records
0 2,500 5,000 m
Wildlands
Scale: 1:150,000
Date: 6/06/2013
Cartographer: FM
Format: A3
Dusky Sound
Five Fingers Peninsula
Resolution Island
Breaksea Island
Gilbert Is
Entry I
Breaksea
Acheron Passage
Wet Jacket
Bowen Channel
Cook Channel
Long Island
Anchor Island
Five Fingers Point
West Cape
Lake Fraser
Lake Macarthur
Lake Cadman
Lake Beattie
Lake Swan
Lake Carrick
Mt Richards
Mt Wales
Mt Patten
Mt Lort
Mt Roa
Mt Clerke
Mt Forster
Mt Hodges
Mt Lyall
Mt Forbes
Mt Philipps
Mt Evans
Mt Sparrman
Mt Bradshaw
Mt Inaccessible
The Stopper
Square Top
Saddle Hill
Calm Peak
Harbour Is
Rocky Point
Woodhen Cove
Goose Cove
Earshell Cove
Duck Cove
Porpoise Pt
Passage Point
Shag Islands
Parrot Island
Pigeon Island
Petrel Islands
Anchor Pt
Prove I
Passage Islands
Stop I
Indian I
Many Is
Nomans Island
Seal Islands
Crayfish
Curlew I
Cascade Cove
Fanning Bay
South Point
Hut
Lumaluma Creek
Glen Alpin Pass
Shag River
Coal River
The Lump
Hills
RANGE
Sound

Tuatara

Tuatara (*Sphenodon punctatus*) once had a broad distribution over the North Island and South Island of New Zealand, but by the time Europeans arrived, this species was restricted to offshore islands (Cree and Butler 1993, Towns and Daugherty 1994, Gaze 2001). The primary agents of decline for tuatara are a combination of predation and competition from rodents, in particular the Polynesian rat or kiore, (*Rattus exulans*). It is likely tuatara suffered a similar fate to indigenous frogs in that they were not able to survive the repeated plagues of kiore. The closest extant natural tuatara population is on Brothers Island, Marlborough (Department of Conservation Bioweb Herpetofauna April 2013).

The Dusky Sound project area is considered to be within the former latitudinal range for tuatara (Cree and Butler 1993, Towns and Daugherty 1994), and is also only a little further south than records for St Bathans, central Otago; Jones *et al.* 2009, and further north than a record from dunelands along the southern coast of the South Island (Ros Cole pers. comm. 2013).

Recent research has assessed the feasibility of reintroducing tuatara to the Orokonui Ecosanctuary, which shares the same latitude as the Dusky Sound project area. Investigations have focussed on whether the site provides adequate incubation temperatures to enable tuatara egg/embryonic development, and the production of both sexes (male tuatara are produced in higher incubation temperatures than females). Results have indicated that conditions at Orokonui are challenging to tuatara as only some nests in some years would produce males, incubation would take longer than at sites further north, and many nests would fail altogether (Besson *et al*. 2011). It was concluded that establishing a self-sustaining, free-living population of tuatara at the Orokonui Ecosanctuary may well require the assistance of climate change. These results are directly applicable to the Dusky Sound project area, where nesting conditions are likely to be similarly problematic for successful incubation to hatching of tuatara; this would require assessment of environmental conditions at potential nesting sites within the Dusky Sound project area.

In terms of post-egg survival, tuatara also require predator-free (rodent, mustelid, cat and possum) habitat, with concomitant deep soils that support plentiful burrowing seabirds. Sites with these characteristics are present within the project area, e.g. on Anchor Island and Breaksea Island. Adult tuatara can co-exist with rodents (juveniles are eaten by rats), but the importance of rodents as competitors to tuatara for invertebrate food cannot be underestimated; on islands with both tuatara and kiore, adult tuatara are often in poor condition.

4.10.4 Invertebrates

Dusky Sound and its adjacent fiords, islands and mainland encompassing the project area have not been fully explored for terrestrial invertebrates, but what is known is that the Dusky Sound area harbours a distinctive and important invertebrate fauna. Important features of this invertebrate fauna include:

- Large body size in beetles (e.g. stag beetle *Geodorcus helmsi*), stonefly (e.g. *Holcoperla angularis*) and moths (e.g. ghostmoth *Aoraia aurimaculata*)

leading to flightlessness in groups that usually have flying adults (only the female is flightless in *A. aurimaculata*).

- A suite of species that are confined or almost confined to this part of New Zealand (regional endemics), for example the landsnail "*Powelliphanta" fiordlandica.*
- A high species richness compared to other regions of New Zealand. For example 420 moth species were trapped at a single sheltered coastal locality (B. Patrick, unpublished data, November 1984).
- Invertebrates with brighter coloration and more distinct markings (e.g. moths in the family Noctuidae such as *Meterana pauca* and *Graphania plena*).
- Earlier emergence as adults in spring than elsewhere in New Zealand (e.g. many Noctuidae and Geometridae emerge in July and August; B.Patrick unpublished data, 1984).
- Several nationally rare invertebrate species including the large landsnail "*Powelliphanta" fiordlandica*, knobbled weevil *Hadramphus stilbocarpae* and moth *Meterana pictula.*
- The existence of large-bodied and generally flightless invertebrate species at sea-level.

High rainfall and a relatively benign climate especially in the more sheltered fiords probably accounts for the earlier emergence patterns, brighter coloration and large size of much of the insect fauna (Peat & Patrick 1996). The existence of several large-bodied species at sea-level is unusual in modern New Zealand and probably reflects lower exotic predator pressure.

Effects of mammalian predation

Bremner *et al*. (1984) found that the densities of 13 groups of invertebrates were lower on Breaksea Island (which had Norway rats at the time), and the densities of two groups were lower on Resolution Island (with stoats and deer), compared to Gilbert Island VI (which is free of introduced mammals). These differences were thought to be the result of both disturbance and predation by introduced mammals. The Dusky complex of islands provides good opportunities to more rigorously research such interactions.

Adults of the stag beetle *Geodorcus helmsi* are large-bodied, slow moving, and nocturnal and therefore attractive and easy prey for rodents (Holloway 2007). They are present along the West Coast from Greymouth south and in western Southland, the southern coast, and the Stewart Island/Rakiura region. In a few places, this species is in decline on the mainland (Edmonds 2002) due to habitat fragmentation and loss. While the buried larvae would be more attractive to predators, adults are often present by day in coastal grassland such as that on Five Fingers Peninsula, showing some resilience to rodent and stoat predators.

A large, locally endemic land snail "*Powelliphanta*" *fiordlandica* is present in forest up to treeline within the project area and in adjacent areas of southwest Fiordland

(Walker 2003, Peat and Patrick 1996). At present, this species is not considered threatened, although it is an uncommonly encountered species, and may belong to an undescribed genus. Micro-habitat of "*P*". *fiordlandica* is likely to be degraded to some degree in much of the mainland range due to long-term deer browse (Walker 2003). Walker (2003) called for survey and monitoring of "*P*". *fiordlandica* on Resolution Island and the mainland, and research to confirm the cause of the high levels of mortality apparent in most populations, the taxonomic placement of "*P*". *fiordlandica* within *Powelliphanta*, and the genetic basis for morphological and ecological differences observed between mainland and Resolution Island populations.

Notable species above the treeline

Among the most spectacular insects above the treeline are colourful day-flying moths in the genera *Dasyuris*, *Aponotoreas* and *Notoreas* and the noctuid moth *Ichneutica lindsayi* that has a large-bodied flightless female. Flightlessness also occurs in other insect groups, including freshwater species. Some stoneflies, such as the large black *Holcoperla angularis* (not confirmed as present within the project area) are completely wingless (Peat and Patrick 1996). A puzzling feature of the western Fiordland including the project area is the apparent absence of grasshoppers, which are present in most indigenous grassland and alpine habitats in New Zealand.

Craw (1999) noted the speargrass weevil *Lyperobius coxalis*, a species endemic to the middle-eastern and southern parts of Fiordland, is present on the Heath Mountains in the eastern part the project area. Both adults (to 23 mm in length) and larvae feed on small species of *Aciphylla* and *Anisotome*. The slightly larger *Lyperobius eylesi*, a species known from the Wilmot Pass area just outside the project area, may also be present. More survey is required to confirm the mix of speargrass weevils present on the mountains within the project area.

At least two species of large ghostmoth (Hepialidae) are known from the project area. Both *Aoraia dinodes* and *A. aurimaculata* have flightless females and chocolate brown and white coloured males with wingspans from 67-94 mm, and are present from sea-level to above treeline (Dugdale 1994). In contrast *Aoraia hespera* is known from a single male collected in 1977 at 1,400 m on Mount George, adjacent to the project area. Given the close proximity of this record, further survey above treeline in the project area would most likely encounter this species also.

Important Invertebrate Taxa

The project area encompasses coastal, forest, wetland and alpine habitats that support nationally important populations of invertebrate species, some of which are confined to southwestern Fiordland. Introduced invertebrates are scarce.

A sizeable number of important terrestrial invertebrates, including At Risk taxa, are present within the project area (Table 6). Significant here is the large flightless knobbled weevil (*Hadramphus stilbocarpae*), which has it best South Island populations on the outer exposed coasts of Resolution Island, Outer Gilbert Island III, Breaksea Island (Craw 1999, McGuinness 2001), and nearby Secretary Island (Eric Edwards, Department of Conservation, pers. comm. May 2013). Interestingly the knobbled weevils in the project area feed as larvae and adults on a robust indigenous

carrot *Anisotome lyallii* (Apiaceae) in contrast to populations further south, which feed on two *Stilbocarpa* species (Araliaceae) (Craw 1999). In response to fears of possible local extinction, 40 knobbled weevils were successfully transferred from Outer Gilbert Island III to Breaksea Island in March 1991 (Thomas *et al.* 1992). Earlier, 20 individuals of another large weevil the flax weevil *Anagotus fairburni* were taken from Wairaki Island and released on Breaksea Island in 1990 (Peat and Patrick 1996).

Table 6: Notable indigenous invertebrates recorded within and near the Dusky Sound project area. Threat classifications are from Leschen *et al*. (2012), Mahlfeld *et al*. (2012), Stringer *et al*. (2012), and Buckley *et al*. (2012).

Threat Classification	Group (Family)	Taxon	Notes
At Risk-Naturally Uncommon	Beetle (Carabidae)	*Mecodema rex*	Solander Islands, scattered locations in western Southland, south Westland and Fiordland including Anchor Island (Edmonds 2002, McGuinness 2001)
	Earthworm (Megascolicidae)	*Perieodrilus ricardi*	Resolution Island (Lee 1959)
	Landsnail (Punctidae)	Punctidae sp. 121 (NMNZ M.57797)	Resolution Island; three accessions in NMNZ (four specimens)
	Beetle (Staphylinidae)	*Pseudopsis* sp. 1 (NZAC04001461)	Dusky Sound, Bauza Island, Secretary Island
	Landsnail (Charopidae)	*Ptychodon blacki*	Resolution Island (and Stillwater River and Leslie Clearing, Caswell Sound) (Dell 1955)
	Landsnail (Charopidae)	*Sinployea* "fiordlandica" (NMNZ M.81649)	Mount Troup Ridge and Centre Pass, Dusky Sound, Fiordland; Waihopai Reserve, Invercargill
	Beetle (Curculionidae	*Anagotus* sp. [turbotti group]	Wairaki Island. Host-specific to the coastal tree daisy teteaweka (*Olearia oporina*) (Thomas 1996). Threat classification is strictly for *A. turbotti*
At Risk-Declining	Moth (Noctuidae)	*Meterana pictula*	Coastal Fiordland in small areas including Five Fingers Peninsula with larvae on *Pimelea gnidia*
At Risk-Relict	Beetle (Curculionidae)	*Anagotus fairburni*	Now largely confined to rodent-free islands through its former widespread range. Local records, include Wairaki Island and Breaksea Island. Host-specific to flax (*Phormium* spp.) (Thomas 1996, McGuinness 2001)
	Beetle (Curculionidae)	*Hadramphus stilbocarpae*	Present around Foveaux Strait, on The Snares, and on a few islands in the mouth of Breaksea Sound and along the exposed outer coast of Resolution Island and Five Fingers Peninsula and Secretary Island. Host plant of SW Fiordland populations is *Anisotome lyallii* (Craw 1999, Thomas 1996, McGuinness 2001)
Data Deficient	Landsnail (Charopidae)	Charopidae sp. 60 (NMNZ M.100283)	Breaksea Island, Fiordland, two accessions (total two specimens) in NMNZ
Not Threatened	Beetle (Lucanidae)	*Geodorcus helmsi*	Parts of the west and south of the South Island and in the Stewart Island area, including all the mainland and several islands in Fiordland (Holloway 2007)
	Landsnail (Rhytididae)	*"Powelliphanta" fiordlandica*	Patchy distribution in the far south-western corner of Fiordland. Type Locality is Five Fingers Peninsula. Large genetic distance to other Rhytid landsnails (Walker 2003)

4.11 Freshwater fauna

Dusky Sound is the Type Locality for giant kokopu (*Galaxias argenteus*; At Risk-Declining) an important member of the family Galaxiidae (McDowall and Frankenberg 1981).

The New Zealand Freshwater Fish Database has records for eight indigenous fish species and one indigenous crustacean within the Dusky Sound project area (Table 7). Most of these species are widespread, being present on islands and the mainland (Figure 8). However, there was only one mainland record for common bully (*Gobiomorphus cotidianus*) from an unnamed stream flowing into Cascade Cove. Several lowland stream habitats on Resolution Island support occurrences of giant kokopu. Koura (*Paranephrops zealandicus*; Chronically Threatened-Gradual Decline) have only been recorded in an unnamed stream in Cascade Cove and on Resolution Island. The introduced brown trout (*Salmo trutta*) was recorded in the Seaforth River, a Mike River tributary, and in Hilda Burn.

Table 7: New Zealand Freshwater Fish Database records for the Dusky Sound project area. Threat classifications for fish are from Allibone *et al.* (2010) and for crustaceans from Hitchmough *et al*. (2007).

Threat Classification	Species	Common Name
At Risk-Declining	*Anguilla dieffenbachii*	Longfin eel
	Galaxias argentus	Giant kokopu
	Galaxias brevipinnis	Koaro
	Galaxias maculatus	Inanga (inaka)
	Gobiomorphus huttoni	Redfin bully
Chronically Threatened-Gradual Decline	*Paranephrops zealandicus*	Koura
Not Threatened	*Anguilla australis schmidtii*	Shortfin eel
	Galaxias fasciatus	Banded kokopu
	Gobiomorphus cotidianus	Common bully
Introduced and Naturalised	*Salmo trutta*	Brown trout

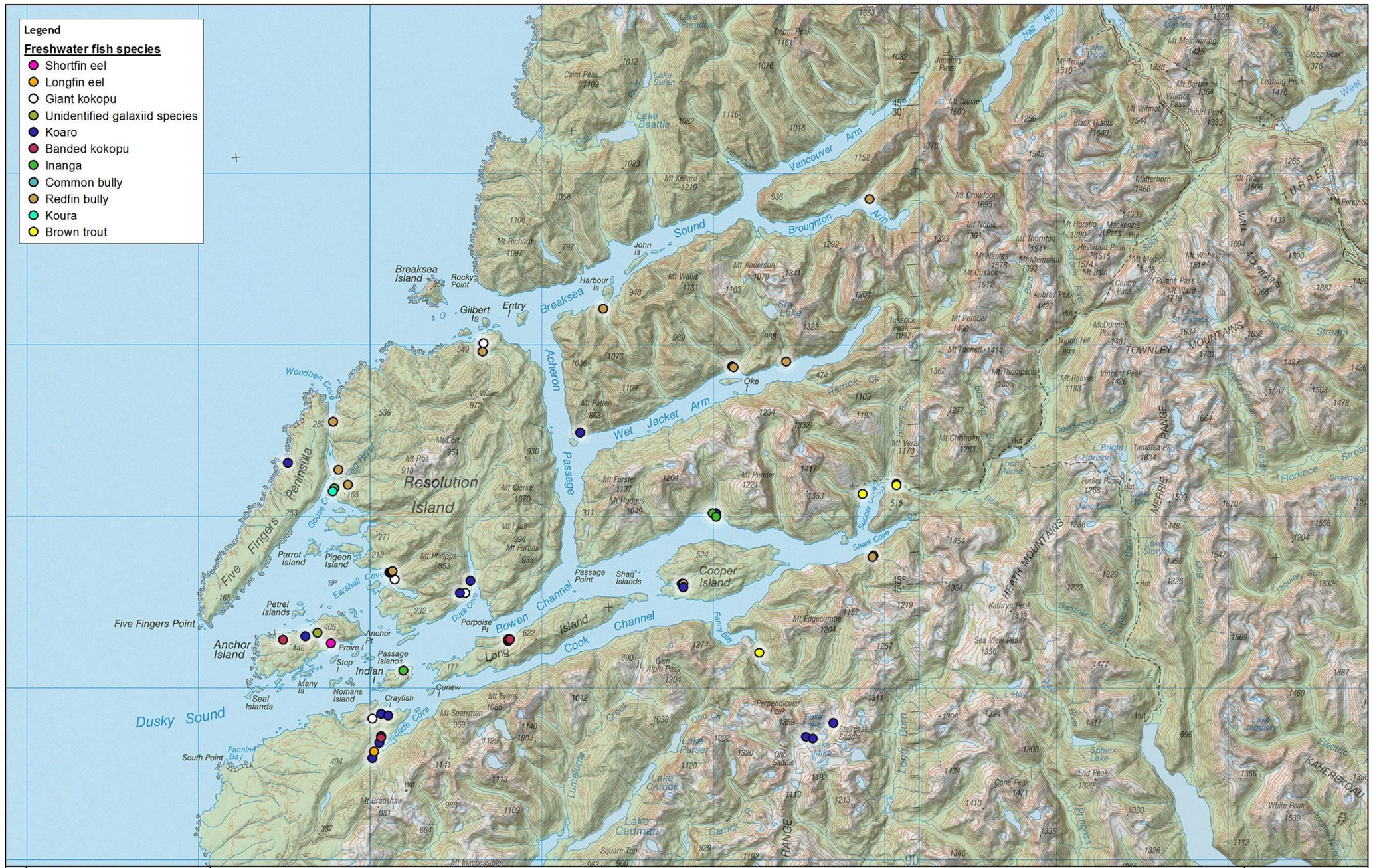


Figure 8: NZ Freshwater Fish Database records for Dusky Sound, Breaksea Sound, and Acheron Passage catchments

4.12 Marine communities

4.12.1 Seaweeds and kelp

Physical and biological factors combine to determine the distribution and abundance of marine algae. Physical factors include the quantity and quality of light (determined by the low salinity layer and topographic shading), salinity (influenced by rain fall), mixing (influenced by wave action) and tidal current (influenced by narrow topographic features such as headlands and guts) (Nelson *et al.* 2002). The strong physical gradients in Fiordland mean that a wide range of niches, from the wave-washed open coast to low-salinity estuarine regions, are available to support a broad diversity of kelp species. Biotic factors influencing the distribution of marine algae include herbivory (in particular by kina) and competitive interactions. On some New Zealand reefs, where large predatory reef fish and rock lobster have been removed by fishing, kina grazing pressure can be sufficient to reduce kelp forests to barren areas (Shears and Babcock 2002). There is some evidence that since the establishment of Moana Uta Marine Reserve in Wet Jacket Arm, there has been a build up of kina predators, a decline in kina, and an increase in kelp forest. In a survey conducted in 2010, kina densities were lower in six Fiordland marine reserves than in adjacent areas (Willis *et al.* 2009).

In the southern fiords, the composition of the kelp community is most similar to that present at Stewart Island (Nelson *et al.* 2002). On the exposed open coast, a mixed species assemblage is present, dominated in shallow depths by bull kelp (*Durvillaea antarctica*). In semi-exposed regions in the fiord entrances, the kelp forest is dominated by the stiptate kelp *Ecklonia radiata*. These kelps provide habitat complexity and an important food source for the marine food web within the fiords (Wing *et al.* 2001, Davis and Wing 2012, Jack and Wing 2012). The morphology of *E. radiata* varies along the fiord axis, from narrow thick blades in exposed areas to thin, wide blades in quiescent, shaded sites in the inner fiord, where *E. radiata* is present at lower density (Wing *et al.* 2007). The heads of the fiords are dominated by estuarine and fresh water algae including sea lettuce (*Ulva pertusa*), Neptunes necklace (*Hormosira banksii*) and *Enteromorpha* species.

4.12.1 Invertebrates

Commercially exploited invertebrate species in the Dusky Sound project area include paua, kina, and rock lobster. The most productive habitat for all three species is present towards open coast although rock lobster and kina are both present at lower densities in most inner-fiord regions.

Rock lobster are strongly associated with intertidal mussel beds, which are an important food resource (Witman and Grange 1998; Jack *et al.* 2009, Jack and Wing 2012). In 2002, when rock lobster fishing took place throughout the Dusky Sound complex, the fishery was reported to be in decline. In the Fiordland region, mature size distributions of rock lobsters are generally only observed within protected areas. Since implementation of the FMA, significant increases in lobster densities have only been observed in marine reserves and not in commercial exclusion zones or on the open coast. In the project area, increases have been greater in reserves situated in more productive habitats nearer to the open coast. Increases in rock lobster densities

have been observed in both Moana Uta (Wet Jacket) and Taumoana (Five Fingers) Marine Reserves since their closure to fishing in 2005, but similar increases have not been seen in the commercial exclusion zone.

The distribution of paua is determined by the abundance of kelp, which is their main source of food. The main Fiordland stocks of paua are present in the outer regions of the Dusky Sound complex. Kina stocks are bountiful in the region, but they are currently not exploited due to the difficulties and costs of maintaining a live shellfish fishery.

Extreme environmental gradients (both along the fiord axis and with depth) create a high diversity of niches available for sessile invertebrates (Smith and Witman 1999). In addition, light limitation due to the stained low-salinity layer and topographic shading results in deep water emergence of rare species such as black corals (*Antipathes fiordensis*) and red corals (*Errina novaezelandiae*), bryozoans, and brachiopods (*Terebratella* spp.), and an overall vertical compression of species distributions resulting in especially high biodiversity (Smith and Witman 1999). The resulting highly diverse communities of fragile encrusting invertebrates in Fiordland are of international significance.

The community is highly stratified by depth and position along the fiord axis, with greater vertical stratification in inner fiord regions (Wing and Jack 2010). In general, shallower regions are characterised by greater abundances of barnacles and blue mussels. Deeper sites (15-10 m) are characterised by higher abundances of black corals, red corals, and brachiopods.

Biodiversity hotspots for these communities are often associated with strong currents such as occur around headlands or in guts. The FFMA identified small discrete areas or 'China Shops' that are outstanding for the abundance or diversity of animal communities, animal and plant communities, or a particular species. Twenty-five China Shops have been recognised in the Fiordland Marine Area and five are present in the Dusky Sound complex. In Breaksea Sound, the wall before First Cove is considered the best example of suspension-feeding communities in Breaksea Sound. In Vancouver Arm, high densities of brachiopods are present along the north wall. In Acheron Passage at the reef off Wet Jacket Arm, there is a region of high current unaffected by silt, where there are notable examples of large black corals and bryozoans. In Cook Channel (Dusky Sound) around Long Island, high densities of particularly large bryozoans, black corals, and red corals are present in regions of high current. In Nine Fathom Passage, where the narrow gut results in high currents, there are especially dense colonies of large bryozoans and black and red corals. These China Shops were designated on a relatively ad-hoc basis based on the experiences of a few key researchers in the region. It is acknowledged that much remains unknown about the distribution of rare and fragile encrusting organisms in this region and many significant examples of highly diverse communities or high densities of specific species are still likely to be discovered. Many taxa in these communities remain undescribed. A recent, systematic investigation of biodiversity in Fiordland's China Shops found 21 ascidian species, which are new to New Zealand and possibly to science (Willis *et al.* 2010). The highest diversity of encrusting invertebrate species in Fiordland was present in Breaksea Sound within the Dusky Sound project area.

The suite of mobile invertebrate species present in the Dusky Sound complex is similar to that present elsewhere in Fiordland (except for Long Sound, which is distinct). Communities are stratified along the fiord axis and this stratification is compounded with depth. In outer-fiord regions, grazing species including kina and top shells (*Callistoma spp.*) are more abundant, probably due to the abundance and diversity of large kelps. Also more abundant are predators of grazing species including the snake star (*Ophiopsammus maculata*). The abundance of sea cucumbers (*Australostichopus mollis*) is strongly associated with inner-fiord habitats and deeper strata.

4.12.2 Reef fish

The information presented here concerns both commercially exploited and non-target reef fish species. Little is known about the distribution and relative abundance of pelagic fish species, including sharks, in the Fiordland region.

Most information regarding the distribution of sharks and other elasmobranchs is anecdotal although common species have been enumerated during reef fish surveys (*e.g.* Willis *et al*. 2009, Wing and Jack 2010). Broadnose sevengill sharks (*Notorynchus cepedianus*) are relatively common in the inner waters of Fiordland and schooling has been observed in the summer time in estuarine habitat, a behaviour that is perhaps related to breeding (Steve Wing, University of Otago, pers. comm.). Mako sharks (*Isurus oxyrinchus*) have been observed in the inner waters of Fiordland and their presence is thought to be associated with warm water arriving into the fiords on the Tasman current. Great white shark (*Carcharodon carcharias*) sightings have been reported in the region, especially around fur seal colonies. Blue sharks (*Prionace glauca)* are a pelagic species present along Fiordland's open coast (Wing and Jack 2007). Other common sharks seen by divers or reported anecdotally as bycatch include rig (*Mustelus Lenticulatus*), school shark (*Galeorhinus galeus)* and spiny dogfish (*Squalus acanthias*). Other common elasmobranchs include long-tailed sting rays (*Dasyatis thetidis*), eagle rays (*Myliobatis tenuicaudatus*), the endemic electric ray (*Torpedo fairchildi)* and deep-water emergent species including ghost sharks (chimera). Ray species are commonly seen in shallow estuarine habitat.

Of the harvested species in the FMA, blue cod (*Parapercis colias*) is acknowledged as the most vulnerable to depletion. Before implementation of the FMA, blue cod stocks in Breaksea Sound were noted to be in decline. Associated with sandy bottom, gravel and debris habitat, blue cod are picivorous omnivores. Populations of blue cod on the open coast are more productive and likely sustain populations in the inner fiords through low rates of unidirectional migration (Beentjes and Carbines 2005; Rodgers and Wing 2008). Since implementation of the FMA, blue cod abundance has increased within some Fiordland marine reserves, but not in the other management zones (Wing and Jack 2010). The greatest increases in blue cod densities have been in the larger marine reserves, particularly those with larger buffers against commercial fishing (Jack and Wing in press). Since the implementation of the FMA, significant increases in blue cod density have been recorded in Moana Utu Marine reserve (Wet Jacket Arm), but not Taumoana Marine Reserve (Five Fingers Peninsular) (Wing and Jack 2010).

In general, the structure of the fish community is stratified by depth and highly correlated with the abundance of the stiptate kelp *Ecklonia radiata*, an important habitat and food resource for both fish and their prey (Willis *et al.* 2009). In the outer fiord, wrasses dominate, including banded wrasse (*Notolabrus fusicola*), girdled wrasse (*Notolabrus cinctus*) and scarlet wrasse (*Pseudolabrus miles*). In inner fiord regions, butterfly perch (*Caesioperca lepidoptera*) are common (Willis *et al.* 2009; Wing and Jack in press).

Since implementation of the FMA, the biodiversity of reef fish has increased measurably within marine reserves but remains unchanged in commercial exclusion zones and in areas open to commercial fishing (Wing and Jack in press). Marine reserves in general have experienced an increase in higher trophic level exploited species including blue cod, sea perch, tarakihi (*Nemadactylus macropterus*), and trumpeter (*Latris lineata*) whilst exploited regions have experienced declines in large omnivorous species and increases in forage fish such as butterfly perch and telescopefish (*Mendosoma lineatum*) (Wing and Jack in press).

4.13 Marine mammals

Three closed or semi-closed populations of bottlenose dolphin (*Tursiops truncatus*; Threatened-Nationally Endangered[16]) utilise the FMA, occupying the northern fiords, the Doubtful Sound complex, and the Dusky Sound complex respectively. This species is common at a global scale, and at this scale is classified as 'Least Concern' by the IUCN (IUCN 2012). However, in Fiordland these dolphins are at the southern limit of the species range and it is thought that the fiords provide marginal habitat, which may make them more susceptible to anthropogenic impacts (Schneider 1999; Hasse and Schneider 2001; Lusseau and Wing 2006; Currey *et al.* 2007; Currey *et al.* 2008; Currey *et al.* 2009; Currey *et al.* 2010; Rowe *et al.* 2010). Fiordland bottlenose dolphins were therefore recently classified as 'Critically Endangered' (IUCN 2012) due to the low numbers of mature individuals and a predicted population decline.

Based on a 2009-2012 photo-ID survey, the Dusky Sound complex bottlenose dolphin population currently consists of approximately 122 individuals (Henderson 2013). This population is considered to be resident in the Dusky Sound complex and relatively isolated from other populations (Currey *et al.* 2008; Henderson 2012). Adult survival in this population is relatively high (0.966; 95% CI: 0.944-0.980), but calf survival rate is very low compared with populations elsewhere in the world (0.722; 95% CI: 0.556-0.844). Age-structured stochastic population modelling indicates that, in the long term, the population is in decline (Henderson 2013).

The distribution of bottlenose dolphins in the Dusky Sound complex varies seasonally. In winter, the dolphins avoid the coldest waters in the inner fiords. During the summer months dolphins can be seen throughout the fiord complex. In contrast to the wall-associated diving behaviour seen in Doubtful Sound, most long dives (presumed to be foraging dives) occur in the more open parts of Dusky Sound, suggesting either that the dolphins are foraging on pelagic prey (a common seasonal prey source for dolphins elsewhere; Würsig and Würsig 1979, Felix 1994), or that they are foraging deep, near the bottom of the fiord (Henderson 2013).

[16] Threat classifications for marine mammals are from Baker *et al*. (2010).

Numerous studies on bottlenose dolphins have shown that interactions with boats can result in decreased resting, socialising, and/or foraging (Constantine *et al.* 2004; Miller *et al.* 2008; Visser *et al.* 2011) and increased travelling (Stensland and Berggren 2007; Miller *et al.* 2008; Arcangeli and Crosti 2009). In addition, boat noise is an important disturbance to bottlenose dolphin communication (Parijs and Corkeron 2001; Buckstaff 2004; Lemon *et al.* 2006). Due to potential disturbance, the Marine Mammals Protection Regulations 1992 and the dolphin-research vessel interaction restrictions mediate the interaction of vessels with dolphins in the Dusky Sound complex. Research vessel limits permit 300 hrs spent at 100-400 m from dolphins per annum and 100 hrs closer than 100 m.

Little data exist regarding the abundance and distribution of other marine mammal species in the Dusky Sound complex. Marine mammal surveys conducted in 2007 and 2010 recorded opportunistic sightings of marine mammals to create a basic species list for inner and outer fiord habitats. Common dolphin (*Delphinus delphis*; Not Threatened), New Zealand sea lion (*Phocarctos hookeri*; Threatened-Nationally Critical), and killer whale (*Orcinus orca* Threatened-Nationally Critical or Vagrant depending on ecotype) have been observed in outer fiord habitats, and bottlenose dolphin, New Zealand fur seal (*Arctocephalus forsteri*[17]; Not Threatened), and Southern elephant seal (*Mirounga leonina*; Threatened-Nationally Critical) in inner fiord habitats. There are also common sightings of Dusky dolphins (*Lagenorhynchus obscurus*; Not Threatened), humpback whales (*Megaptera novaeangliae*; Migrant), and southern right whales (*Eubalaena australis*; Threatened-Nationally Endangered) within the project area (pers. comm. Department of Conservation, May 2013).

Populations of New Zealand fur seals populate the coasts of Fiordland and rookeries are known on Breaksea Island, at Luncheon Cove, on the southern end of Anchor Island, at Seal Island, and on Resolution Island. New Zealand fur seals forage offshore, exploiting the deep scattering layer. It is not known how these populations utilise the Fiordland Marine Environment.

4.14 Terrestrial-marine interface

The restoration of terrestrial vegetation may have far reaching effects beyond the terrestrial ecosystem and, in turn, management to enhance marine productivity can enhance terrestrial biodiversity. Many of these interactions 'across ecotone boundaries' are mediated by seabirds (Polis and Hurd 1996; Sánchez-Piñero and Polis 2000; Hawke and Holdaway 2005). For example, loss of seabirds on islands can result in a striking transformation of plant communities driven by changes in the availability of marine nutrients delivered to the terrestrial system in seabird guano (e.g. Croll *et al.* 2005). Along restored coastlines, guano from increased numbers of roosting and breeding seabirds can increase nutrient levels in adjacent waters, stimulating localised primary productivity, which in turn supports greater localised densities of higher trophic level marine species (e.g. McCauley *et al.* 2012). The focus of conservation efforts is often on particular species or community biodiversity, but the conservation of ecological interactions is rarely considered.

[17] Scheffer (1958) restricted the Type Locality of *Arctocephalus forsteri* (Lesson, 1828) to "Dusky Sound, New Zealand".

In Dusky Sound, an exciting opportunity exists to remove exotic predators of seabirds from offshore islands, enhancing the potential for flow of marine nutrients back on to islands with the prospect of stimulating localised terrestrial productivity and productivity in adjacent marine habitat that is protected from fishing.

In addition, and unique to Fiordland, inner- to mid-fiord regions are inundated with terrestrial material, which is forced by the high rainfall and steep-sided topography into the marine environment. This terrestrial material is an important supplement to marine food webs, sustaining stable populations of key iconic and exploited species (including lobsters and blue cod) in these otherwise low productivity habitats (McLeod and Wing 2007; Jack *et al.* 2009; McLeod and Wing 2009; Wing *et al.* 2012). If the structure and composition of coastal forest vegetation is enhanced by removing browsing pests such as possums and deer, then natural flows of terrestrial material into the marine environment should also be enhanced.

Finally, the removal of browsing pests in the adjacent terrestrial ecosystem has the potential to reduce excessive landslips caused by browse-induced damage to indigenous forest. The steep walls of the Fiordland marine realm host a unique and diverse array of fragile and encrusting organisms. Landslips are likely to be a significant part of the natural disturbance ecology for these vulnerable sessile marine organisms, which may be smothered or scoured by terrestrial debris. The removal of terrestrial browsing pests has the potential to restore a more natural frequency of landslips, which might sustain a natural level of disturbance below that which is detrimental to populations of sessile marine organisms.

5. MANAGEMENT ISSUES/THREATS

5.1 Pest animals

Red deer are a major threat to indigenous vegetation and can cause major changes to indigenous habitats, making them less favourable to indigenous fauna (e.g. takahe; Wickes *et al*. 2009). In forest habitats, their effects are concentrated in the understorey, where regeneration of palatable tree species is prevented even under moderate deer densities. Rodents feed on fruit and seeds of indigenous plant species and thus have the potential to affect dispersal, regeneration and recruitment processes (e.g. Moles and Drake 1999; Wilson *et al.* 2007). Possums (*Trichosurus vulpecula*), which are present on the mainland part of the project area, are significant browsers of canopy vegetation, including flowers, fruits, and seeds (Cowan 1990), and also target species such as indigenous mistletoes (e.g. Sweetapple *et al.* 2002). Some plant species are affected by only a narrow suite of herbivores. For example, broadleaf, which is highly favoured by red deer (Nugent *et al.* 2001), is likely to respond rapidly to effective control of deer in the project area, since its seeds are avoided by mice (Wilson *et al.* 2007) and its foliage is avoided by possums (Nugent *et al.* 2001).

Rodents (kiore, ship rats, Norway rats, mice), possums, and stoats (*Mustela erminea*) have adverse effects on all indigenous forest bird species, either to the point of extirpating particularly vulnerable species such as kokako and mohua, or by reducing the abundance of less vulnerable species such as tui (*Prosthemadera*

novaeseelandiae) and kereru through both predation and competition for food resources. Ground-nesting and hole-nesting birds such as Southern Fiordland tokoeka (*Apteryx australis*), mohua, South Island kaka, and kea (*Nestor notabilis*), and burrow-nesting seabirds such as sooty shearwater, mottled petrel, broad-billed prion, Fiordland crested penguin and southern blue penguin are all vulnerable to predation by stoats. The direct and indirect impacts of mice on indigenous New Zealand birds are less well understood, but are likely to be greater on islands and above bushline where mice (*Mus musculus*) are the only rodent present (e.g. Resolution Island and mainland ranges), and likely to be greater still following release from predation when stoats on such islands are eradicated or controlled (see Angel *et. al* 2009). All bird species are likely to have suffered indirect impacts from the invasion of red deer, and subsequent changes in forest understorey structure, composition, and condition.

The introduction of terrestrial mammals to many of the islands within the Dusky Sound project area caused many extinctions, and will also have triggered significant declines in surviving fauna populations. In the absence of pest control or eradication, some fauna populations will continue to decline. Invasion of new pests (particularly stoats and ship rats (*Rattus rattus*) or reinvasion of eradicated pests could result in the further loss of fauna. Eradication or control of existing pests (mainly stoats, red deer, and rodents) will be necessary in order to successfully reintroduce highly vulnerable bird species such as little spotted kiwi and South Island saddleback

Herpetofauna values over the Dusky Sound project area are primarily threatened by introduced exotic mammalian predators, especially rodents but also stoats and probably possums. Mice are known predators of New Zealand skinks, geckos and frogs, and are also known to compete for food with tuatara.

Stoats, possums, and rodents are predators of indigenous invertebrate species, and in addition to the direct effects of predation, indigenous invertebrate assemblages are affected by changes in habitat quality due to browsing, trampling, and other disturbances caused by pest animals (Bremner *et al*. 1984).

5.1.1 Patterns of pest animal invasion

Islands in the project area offer significant advantages as refuges from mammalian predation, as several are in pristine condition and many others have been subject to successful pest eradication programmes (Table 8; Figure 9). Several of the smaller and more isolated islands, including Wairaki Island in the outer Gilbert Island group, and Prove Island, Stop Island, Nomans Island, the Passage Islands, and Thrum Cap in Dusky Sound, may never have been invaded by pest animals and are thus in pristine condition.

None of the islands in Dusky Sound have been invaded by possums, as possums are poor swimmers and have only recently invaded adjacent mainland areas (where numbers are increasing).

Rodents are not known to have been present on Anchor Island and several of its outlying island groups (the Many Islands, Petrel Islands, and Seal Islands). Hawea Island and Breaksea Island were the subject of early, and successful, eradications of Norway rat (*Rattus norvegicus*) in 1986 and 1988 respectively (Taylor and Thomas

2002). Norway rats probably invaded these islands during early periods of seal hunting activity and as the islands are seldom visited now, reinvasion is unlikely (Taylor and Thomas 1989). Rats are currently absent from Resolution Island, although a single ship rat (*Rattus rattus*) was trapped near Fixed Head in 2006. Ship rats have not been caught on Indian Island since the 2010 eradication, but are present on Long Island and the small islets between Long Island and Indian Island. Mice are present on the mainland, Resolution Island and Entry Island, and likely to be present on Long Island, Cooper Island, and other islands, but their distribution within the Dusky Sound project area has not been comprehensively determined.

Some islands within the project area have never been invaded by stoats (*Mustela erminea*), i.e. all the pest-free islands that have not had stoat eradications (Table 8). Stoats were eradicated from Anchor Island and its outlying islands in 2001, with deer also being eradicated by 2007, resulting in pest-free status for these islands. Rodents were eradicated in 2010 from Indian Island by Department of Conservation in partnership with the Fiordland Conservation Trust, and on-going stoat control is being maintained on the island because of occasional stoat reinvasion. Stoat and deer control is currently being undertaken on Resolution Island, and while no stoats have been caught on the Five Fingers Peninsula since 2010, they have not yet been eradicated from the remainder of Resolution Island. Deer are still present throughout Resolution Island, although their numbers have been strongly reduced due to control operations.

Table 8: Pest animal status of major islands and island groups in the Dusky Sound project area. *East Point Island refers to the unnamed island at the east end of Long Island.

Island/Island Group	Area (ha)	Pest Eradications	Current Pest Status
Anchor Island	1,137	Stoat 2001 Deer 2007	Pest free
Breaksea Islands	156	Norway rat 1988	Pest free
Entry Island	38	Weka	Mice present, other pests absent
Many Islands	32	Stoat 2001	Pest free
Seal Islands	29	Stoat 2001	Pest free
Petrel Islands	28	Stoat 2001	Pest free
Nomans Island	20		Pest free
Passage Islands	18		Pest free
Outer Gilbert Islands	11		Pest free
Hawea Island	8	Norway rat 1986	Pest free
Wairaki Island	2		Pest free
Stop Island	10		Pest free
Prove Island	8		Pest free
Thrum Cap	4		Pest free
Indian Island	168	Ship rat, house mouse (2010), stoat (1999), red deer (2003)	Occasional stoat captures since 2010
Parrot Island	40		Possum and rat free, occasional stoat reinvasion
Pigeon Island	73	Stoat 2005	Possum and rat free, occasional stoat reinvasion
Resolution Island	20,887	Ship rat 2006 (one individual)	Possum and rat free, stoat and deer control being undertaken
Useless Islands	3		Possum and rat free
Long Island	1,899		Possum free, stoat control initiated 2012. other pests uncontrolled

Cooper Island	1,779		Possum free, other pests uncontrolled
John Islands	58		Possum free, other pests uncontrolled
Inner Gilbert Islands	56		Possum free, other pests uncontrolled
Harbour Islands	48		Possum free, other pests uncontrolled
East Point Island*	45		Possum free, other pests uncontrolled
Oke Island	35		Possum free, other pests uncontrolled
Girlies Island	17		Possum free, other pests uncontrolled
Curlew Island	12		Possum free, other pests uncontrolled
Crayfish Island	9		Possum free, other pests uncontrolled
Heron Island	6		Possum free, other pests uncontrolled

The reinvasion risks for each island are variable and depend on factors such as the combination of pests present on surrounding islands, the distance to the mainland and the network of intervening stepping stone islands. For this reason, reinvasion risk is not easy to assess accurately. A broad island invasion risk assessment of the various animal pest species present in Dusky Sound is presented in Table 9. Species considered highest risk are presented first.

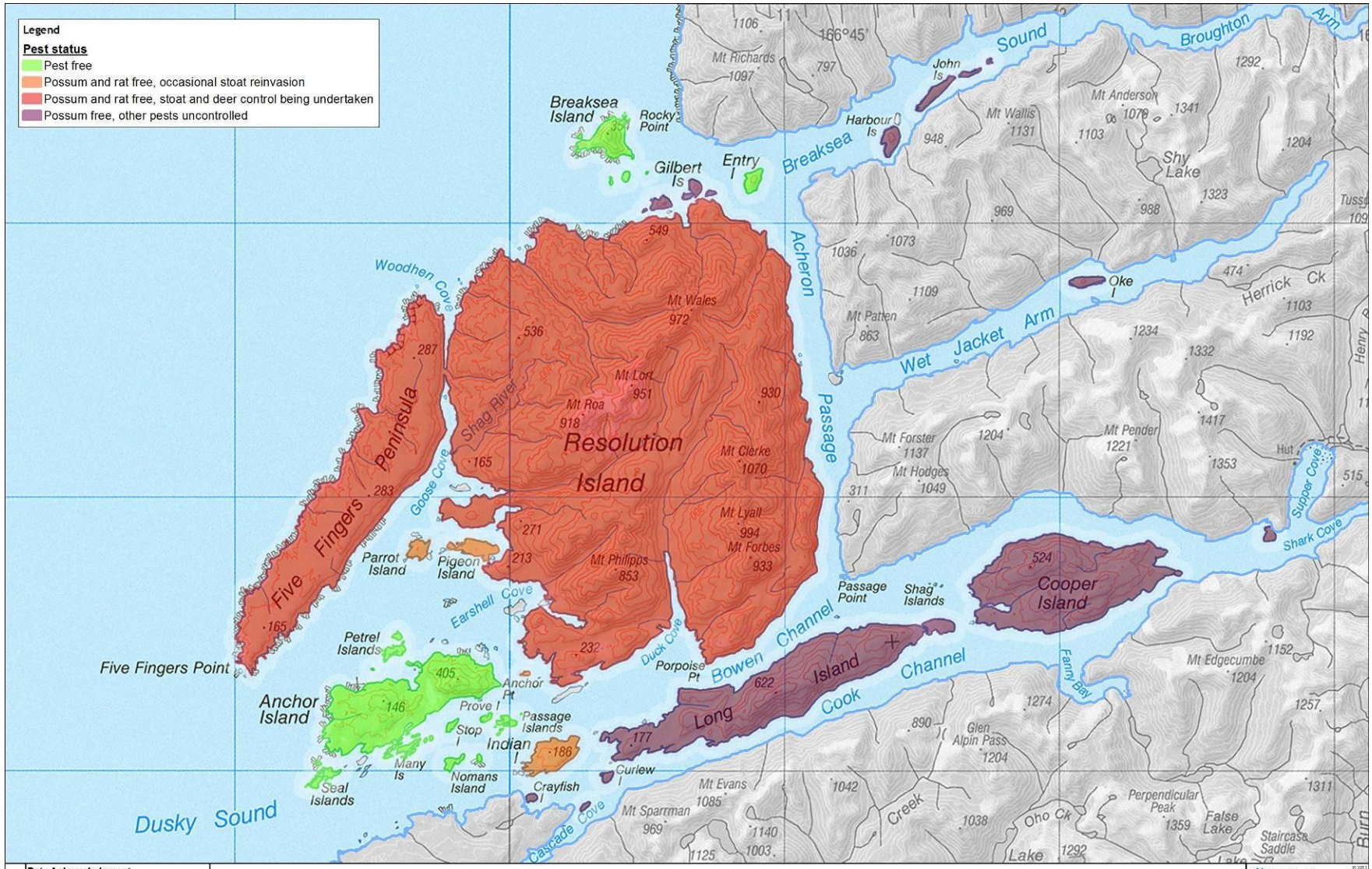


Figure 9: Current pest status of Dusky Sounds Islands

Table 9: Pest animals within the Dusky Sound project area: invasion risks and management options.

Species	Invasion Pathway		Dusky Sound Islands				
	Swim	Stowaway	Dusky Sound Distribution	Invasion Risk	Eradication Techniques	Control Techniques	References
Stoat	High At least 1,200 m in Fiordland?	Medium	Low number on Resolution Island. Occasional on Pigeon, Parrot, Indian Islands. Present on Long and Cooper Islands. Widespread on Dusky Sound mainland	Greatest invasion risk is during beech mast-driven rodent and stoat population irruptions. Numbers of stoats thought to be swimming to Secretary Island each summer = 3 ("normal" year), =11 (beech mast year).	• Aerial brodifacoum (all islands with rats) • Trapping • PAPP?	• Aerial 1080 (all islands with rats) • Trapping • PAPP?	King and Murphy in King (ed.) 2005
Red deer	High Excellent swimmers - colonised Secretary and Resolution, both >500 m swims.	Low	Present on Resolution, Long, and Cooper Islands. Eradicated from Anchor and Indian Is. Have probably swum to many smaller islands from time to time but not established. Widespread on Dusky Sound mainland.	Unlikely to be eradicated from Resolution Island in the short term, given experience to date? However, risk of invasion of other islands may be low. Crouchley *et al.* 2011 state the low genetic diversity of deer on Secretary Island indicates invasion is a rare event, representing a single invasion when deer populations were much higher than present.	Ground and aerial hunting.	Ground and aerial hunting.	Crouchley *et al.* in Veitch *et al.* (eds.) 2011; Crouchley *et al.* 2007
Ship rat	High Up to 300 m, South Island waters?	High	Present on Long Island and possibly on Cooper Islands. One caught on Resolution in 2006 but no sign since. Eradicated from Indian Is in 2010. Widespread on Dusky Sound mainland	Greatest island invasion risk via accidental introduction, and during beech mast-driven rodent and stoat population irruptions?	• Aerial brodifacoum	• Aerial 1080 (all islands with rats) • Bait-station toxins (on easier-terrain islands?)	Innes in King (ed) 2005; Fiordland Conservation Trust website
Norway rat	High Possibly up to 1 km.	High	Eradicated from Breaksea and Hawea Islands; historic sign on Resolution Island.	Low invasion risk as no longer present on Dusky Sound islands and possibly gone from Fiordland mainland? Qualified by uncertainty over island distribution.	• Aerial brodifacoum	• Aerial 1080 (all islands with rats) • Bait-station toxins (on easier-terrain islands?)	Russell *et al.* 2008; Innes in King (ed) 2005; IRP 2010
Mouse	Medium Possibly up to 1 km?	High	Present on Resolution and Pigeon Is. Possibly present on Long, Cooper and Parrot Is. Eradicated from Indian Is. in 2010.	Greatest island invasion risk via accidental introduction, and during beech mast-driven rodent and stoat population irruptions? Dusky Sound island distribution needs	• Aerial brodifacoum (successful up to 3,842 ha - Rangitoto-	Bait-station toxins (on easier-terrain islands?)	Ruscoe and Murphy in King (ed.) 2005; Fiordland Conservation

Species	Invasion Pathway		Dusky Sound Islands				
	Swim	Stowaway	Dusky Sound Distribution	Invasion Risk	Eradication Techniques	Control Techniques	References
				further investigation.	Motutapu) but probably riskier in tall forest habitats (e.g. not successful at Maungatautari)		Trust website
Weasel	High At least 1,200 m in Fiordland?	Medium	Uncertain distribution on mainland. Has not been found on any Dusky Islands.	Unlikely to invade by swimming or by accidental introduction.	• Aerial brodifacoum (all islands with rats) • Trapping • PAPP?	• Aerial 1080 (all islands with rats) • Trapping • PAPP?	King in King (ed.) 2005
Possum	Low Can swim, but generally avoid water.	Low	Absent from islands. Present on Dusky mainland.	Unlikely to invade islands by swimming, most likely by deliberate introduction.	• Aerial brodifacoum	• Aerial 1080	Cowan in King (ed.) 2005
Kiore	Low Numerous islets <65 m from kiore-inhabited islands never colonised.	Low	Absent from islands - and low/patchy distribution on mainland Fiordland - possibly absent from Dusky Sound.	Unlikely to invade islands either by swimming or accidental introduction.	• Aerial brodifacoum	• Aerial 1080?	Atkinson and Towns in King (ed.) 2005
Ferret	Low Will swim rivers but never established on offshore islands.	Low	Absent from islands. Probably absent from mainland buffer zone.	Absent from Dusky Sound islands and probably absent from mainland buffer zone.	• Aerial brodifacoum (all islands with rats) • Trapping	• Aerial 1080 (all islands with rats) • Trapping	
Feral cat	Low Can swim, but generally avoid water.	Low	In low numbers if present at all/ on Dusky Sound mainland? Not present on Dusky Sound islands.	Introduced by sealers to Anchor Island 1792, probably (?) died out.	• Aerial brodifacoum (all islands with rats) • Trapping • PAPP? • Hunting	• Aerial 1080 (all habitats with rats) • Trapping • PAPP?	Gillies and Fitzgerald in King (ed.) 2005; Innes 2008.
Feral	High	Low	Absent from mainland within	Possibly vulnerable to invasion if	• Ground hunting	• Ground	McIlroy in King

Species	Invasion Pathway		Dusky Sound Islands				
	Swim	Stowaway	Dusky Sound Distribution	Invasion Risk	Eradication Techniques	Control Techniques	References
pig	Good swimmers - e.g. present 200 m offshore, Lake Taupo		the project area but range increasing in Waitutu and south-eastern Fiordland National Park Periodic sightings of pig rooting at Puysegur Point and West Cape area.	feral pigs colonise Fiordland NP or illegally released.	• Trapping	hunting • Trapping	(ed.) 2005; R. Ewans, DOC, pers. obs.

5.1.1 Non-target effects of pest control

Use of toxic baits for pest control has the potential for non-target effects on indigenous species. For example, it is possible that both the short-tailed bat and the long-tailed bat are present in the Dusky Sound project area. Bats may ingest toxins either directly or indirectly (via consumption of invertebrates), resulting in their death or acute poisoning. This occurred in the Pureora Forest Park in 2008, when use of a first generation anticoagulant toxin diphacinone in a paste matrix resulted in the deaths of a large number of short-tailed bats (O'Donnell *et al.* 2011). To prevent or reduce non-target effects of toxins used in pest control, all pest control operations should follow current Department of Conservation best practice for areas where susceptible indigenous species are present.

5.2 Terrestrial weeds

Resolution Island has records for 25 exotic plant species (one shrub, seven grass, three rush, and 14 dicotyledonous herb species), which are mainly restricted to sites of human disturbance such as bivvies and historical boat landings, or to coastal areas where seeds wash ashore. Gorse (*Ulex europaeus*) is the only woody exotic species present, at Disappointment Cove and Goose/Woodhen Cove (Ewans and Lake 2011) and a few other coastal locations on Long Island and Cooper Island (Richard Ewans, Department of Conservation, pers. comm.). Department of Conservation staff from the Te Anau Area Office visit all of these sites annually to locate and control gorse.

5.3 Marine invasive species

The strong physical gradients in Fiordland are responsible for the diverse array of habitats present within a small area. This habitat diversity means that Fiordland is particularly vulnerable to introduction and establishment of harmful and invasive marine plants, animals, and diseases, many of which are likely to find a habitat that they can exploit. Hundreds of vessels visit the fiords each year for commercial and recreational activities and each one has the potential to bring invasive pests with it. Biofouling, where pest species attach themselves to ships hulls, is a significant means of pests spreading from one location to another. Pests or their spores can also spread in ballast water or on equipment such as moorings, fishing gear, or scientific equipment that have previously been deployed elsewhere. Invasive species can significantly impact the health of marine communities, marine food webs and fish stocks for commercial and recreational fishing. Once established, marine pests can be very difficult to eliminate, so it is critical to prevent initial establishment. There are several marine pests of concern that are already present in New Zealand and which could potentially invade the Fiordland Marine Area (Table 10). These are managed under the Environment Southland Regional Pest Management Strategy (currently under review) and are listed as unwanted pest organisms under the Biosecurity Act 1993.

Table 10: Exotic marine species with potential to invade the Fiordland Marine Area.

Species	Common Name
Undaria pinnatifida	Undaria/ Japanese sea weed
Styela clava	Sea squirt
Didemnum vexillum	Sea squirt
Eriocheir sinensis	Chinese mitten crab
Caulerpa taxifolia	Aquarium sea weed
Potamocorbla amurensis	Asian clam
Carcinus maenas	European shore crab
Asterias amurensis	Northern Pacific seastar
Sabella spallanzanii	Mediterranean fan worm

Undaria (*Undaria pinnatifida*) is considered a significant threat to the Fiordland Marine Area. Undaria is a large, brown, annual kelp, which is indigenous to temperate regions of Japan, China and Korea. Introduction of undaria to New Zealand is thought to have occurred via the persistence of propagules within ballast water (Hay and Luckens 1987). Coastal dispersal around New Zealand is believed to have occurred via external hull fouling and transfer of marine farm equipment or mussel spat. Undaria has the potential to displace indigenous seaweed species and significantly alter habitat for associated fauna including commercial species such as paua and kina (Curiel *et al.* 2002; Silva *et al.* 2002; Valintine and Johnson 2003; Casas *et al.* 2004). Undaria exhibits several traits characteristic of an invasive species that may favour its spread and colonisation of New Zealand tidal rocky shores (Stuart 2003) including:

- A broad ecological niche characterised by an ability to complete its life history over a wide range of temperatures and in different habitats, ranging from highly modified enclosed harbours to semi-exposed open coast.
- A preference for artificial substrates
- An r-selected life strategy characterised by short sporophyte longevity (6-9 months), rapid growth rate (1 cm/day), early maturation (*c*.40-50 days), and high fecundity
- Phenotypic plasticity and the presence of different morphological forms
- No close phylogenetic relatives in the indigenous marine flora.

In April 2010, a single mature plant of undaria was present on a mooring rope at Sunday Cove, Breaksea Sound. Follow-up investigations found a small population of undaria that was not thought to be well established. In response, the Department of Conservation, MPI and Environment Southland initiated an eradication programme. Monthly or five-weekly diver surveys worked to detect and manually remove all sporophytes present in the area, before they reached maturity and released spores. Where very small, newly-recruited plants were suspected, divers poisoned infected areas using chlorine. In addition, around 35,000 kina from surrounding regions were translocated to the infected area in Sunday Cove as a biocontrol agent. Since April 2010, 33 control operations have been conducted in the area removing over 1,800 plants. Since March 2012, only 53 immature undaria specimens have been found despite an increased level of search effort. Only three plants have been found in 2013 and the response team aim to have all undaria eliminated from Fiordland by 2015.

Threats to the Dusky Sound complex marine area are both general, in keeping with the whole Fiordland Marine Area, and specific to the Dusky Sound complex because of unique features of the region. Besides marine invasive species, other threats include:

- Pollution from oil spills, sewage, and rubbish, especially from large cruise ships entering the Dusky Sound complex.
- Physical damage to habitats due to structures, anchoring, ships wakes and landslips
- Impact of increasing access on marine mammals.
- Impact of increasing access on wilderness values and the expectations of visitors
- Impact of increasing access on recreational fisheries

5.1 Biosecurity

The Dusky Sound project area is relatively intact, meaning that implementation of a robust terrestrial and marine biosecurity programme is essential. Significant absences from the Dusky Sound project area are many potentially invasive terrestrial weeds, and marine invasive organisms, but the potential for invasion of these pests and weeds is relatively high, as invasion by pest animals, gorse and undaria show. The current infestations of several pest animals, gorse and undaria are being actively controlled, but control of these weeds and pests, even for those in the early stages of invasion or at low abundance, has been costly and time-consuming, illustrating the critical importance of biosecurity actions that can prevent weed and pest invasion..

5.2 Information storage

As part of this project, Wildland Consultants prepared an 'islands database' for the Dusky Sound project area. This database contains over 700 uniquely-numbered georeferenced islands, the majority small and un-named, which are represented in rows. A preliminary GIS analysis has computed attributes such as island area, perimeter to area ratio, distance to the nearest island, distance to the nearest mainland, and maximum elevation. Attributes for pest animals have been added as columns, and the same could be done for other features such as indigenous vertebrates, historic and cultural features, and management status. We strongly recommend that this database is maintained and enhanced by the Department of Conservation. Protocols should be established for addition or editing of data within the database.

6. PROJECT GOALS

Four goals have been identified for the Dusky Sound restoration project and these are listed below with justifications for each goal. The following section (Section 7) provides detailed objectives and actions by which the goals are to be achieved.

Goal 1: Natural ecosystems, ecological processes, and species are protected by eliminating or controlling to sufficiently low densities marine and terrestrial pest species and by preventing the establishment of new pest species.

While the Dusky Sound project area is relatively intact in terms of its indigenous vegetation cover, the condition of its habitats, and the indigenous plant and animal populations in those habitats, has been affected by multiple pest animal species, and some pest plant species. Key pest species within the project area are red deer, stoats, and rodents in terrestrial ecosystems, and *Undaria pinnatifidia* in the marine environment. Ecological processes such as marine-terrestrial resource flows due to nesting seabirds have been disrupted by these pests, and regeneration failure of palatable tree species is widespread in areas affected by deer, while some indigenous fauna have been made locally extinct, and others have reduced populations due to mammalian predation. Eliminating pest species or controlling them to low levels is the key requirement to restore ecological processes, habitat condition, and species populations to a fully functioning state. At the same time, the Dusky Sound project area is relatively intact, compared to other areas of pest-accessible New Zealand. Further pest species should be prevented from establishing within the project area because of the limitations this would place on the ability of habitats to support threatened indigenous species, and the additional resources that would need to be allocated for pest control and eradication.

Goal 2: Terrestrial ecosystems within the Dusky Sound project area are enhanced through reintroduction of missing (or analogue) species, and biodiversity information gaps are progressively filled.

Many bird species in particular are known to have once occurred in the Dusky Sound project area, but are now locally or globally extinct. A major justification of pest control in the project area is to enable the reintroduction of populations of these missing species, or their analogues with respect to globally extinct taxa. Reintroduced species are not only valuable for their intrinsic worth, but to enhance or restore the ecological functions and processes that these species were formerly involved in. Successful reintroductions also contribute to national recovery goals for populations of Threatened species. Information on a range of biodiversity elements is deficient or lacking, particularly with respect to lizards, seabirds, terrestrial invertebrates, freshwater fish, and vegetation/habitat mapping. As research on the need for and implementation of reintroductions is undertaken, new biodiversity information is likely to be revealed, and should help to fill current biodiversity information gaps. Any remaining gaps should be progressively filled either by specific, targeted, surveys, or by establishing a formal process for obtaining and collating information from casual reports by Department of Conservation staff, visitors, commercial users, and researchers undertaking work in the project area.

Goal 3: Marine ecological functions, habitats, and populations of indigenous species within the Dusky Sound project area are protected and marine-terrestrial interactions are enhanced and marine biodiversity information gaps are progressively filled.

Marine ecological issues differ from terrestrial ecological issues in that protection of existing marine ecosystems, functions, habitats, and species is best accomplished by reducing human impacts, rather than by controlling pest animals and undertaking reintroductions. As marine ecosystems and species are governed by several agencies, and marine research is primarily undertaken by third parties, advocacy, encouragement, and support from the Department of Conservation is crucial to achieving the marine goal. Information on a range of marine biodiversity elements is deficient or lacking, particularly with respect to marine mammals and fragile marine encrusting organisms. Ongoing research on marine ecosystems, species, and ecosystem functions is likely to generate information which will help to address these gaps.

Goal 4: Public and stakeholder participation, in all aspects of the Dusky Sound restoration project has been actively encouraged and facilitated, historic, cultural, and recreational values are not significantly diminished by biodiversity conservation actions, and biodiversity values are not compromised by visitor use.

Gaining public and stakeholder support for the project is critical if it is to be sustained in the long term. The Department should ensure that it communicates effectively with the public and stakeholders, and encourages partnerships with iwi, community groups, researchers and commercial stakeholders to better achieve its biodiversity conservation work. Biodiversity values should be protected from inappropriate visitor use. However important historic, cultural, and recreational values are present in the project area. Biodiversity conservation actions should ideally avoid affecting important historic, cultural, and recreational values. If biodiversity conservation actions are unable to avoid adverse effects on important historic, cultural, and recreational values, consultation with the public and stakeholders should be undertaken, with the aim of finding an agreed solution to minimising adverse effects.

7. OBJECTIVES AND ACTIONS

In this section, objectives are numbered sequentially across goals, while actions are numbered consecutively within objectives. Actions are not listed in order of relative priority, but in several cases, some actions are contingent on other actions being completed first.

7.1 Goal 1: Pest control

Objective 1: Maintain or improve the pest status of all islands that are pest-free or have a limited suite of pests, on an ongoing basis

***Explanation*:** There are *c.*127 islands totalling 1,740 ha that have a pest-free status within the project area. Anchor Island constitutes 65% (1,136 ha) of the total pest-

free island area, and the next two largest pest-free islands (Indian Island (168 ha) and Breaksea Island (153 ha)) together with Anchor Island contribute 84% of the total pest-free island area. Biosecurity processes and contingency planning is important to ensure that these islands remain pest-free. Resolution Island and some of its inshore islands have only mice, stoats, and red deer. Of Resolution's in-shore islands, stoats and deer have been reduced to zero density on Parrot Island and Pigeon Island. All Dusky Sound islands lack a suite of other pest animals that are present on the adjacent mainland including possum, hedgehog (*Erinaceus europaeus*), Norway rat (*Rattus norvegicus*), and kiore (*Rattus exulans*), as well as other pests such as feral pig (*Sus scrofa*) and feral goat (*Capra hircus*) that are not yet well established in coastal Fiordland.

Trapping using Fenn traps and DOC150 traps since 2000 has yielded useful information on the island distribution of ship rats and stoats and, by their non-capture, Norway rats and kiore. However there is no systematic distribution information for red deer or for mice.

***Action 1*:** Continue to implement existing biosecurity plans and procedures.

***Action 2*:** Maintain existing regime of stoat and rat trapping and incursion response deer control.

***Action 3*:** Improve knowledge of pest distributions, particularly mice and red deer, on where information on the islands inhabited by these species is lacking.

***Action 4*:** Maintain an electronic database to hold information on the pest status of all islands in the project area.

Objective 2: Complete the Resolution Island stoat eradication operation by 2020, or if eradication is not feasible, control stoats to low density on an ongoing basis.

***Explanation*:** Stoats can be maintained at low densities on Resolution Islands at lower cost than on the mainland, as immigration from outside the control area is limited. In addition, Resolution Island is significantly more intact than mainland sites, due to the absence of possums and rats, and lowered abundance of deer. Stoat control may allow translocation and establishment of secure populations of highly vulnerable species. Current stoat trapping operations double as surveillance monitoring, allowing detection of stoats at low density. Stoat capture rates are therefore useful for assessing the potential for translocation or reintroduction of indigenous taxa whose populations can grow in the presence of low densities of stoats, but which do not persist at higher stoat densities. The extent to which stoats are suppressing mice on Resolution Island is not known. If stoats are significantly limiting mouse abundance, then maintaining stoats at low densities could result in increases in mouse density. Alternatively, mouse density may be primarily determined by food availability (especially in beech mast years), and show little change when stoat abundance is reduced.

***Action 1*:** Continue/complete stoat eradication operation on Resolution, OR if eradication is not feasible, control stoats to levels below a specified low density.

***Action 2*:** Maintain a spatially explicit database of stoat capture rates and review it annually to refine stoat control.

***Action 3*:** Undertake ongoing monitoring to better understand the dynamics of the mouse population on Resolution Island under a regime of low stoat densities.

Objective 3: Complete the Resolution Island deer eradication operation by 2020, or if eradication is feasible, control deer to low density on an ongoing basis.

***Explanation*:** With other pests absent or held at low density, control of deer on Resolution Island is strategically important, as the potential for significant enhancement of ecosystem function is high in the absence of other pests. Coastal broadleaved forest and scrub in particular is a relatively productive and ecologically important habitat of limited extent in the project area, and is vulnerable to browse by deer. This habitat is well expressed on the western side of the Five Fingers Peninsula. The Five Fingers Peninsula is the most remote part of Resolution Island and is a part of the island where aerial control of deer is more practical. Apart from the Five Fingers Peninsula, Resolution Island has few strategic opportunities for deer control at a sub-island level; therefore reducing deer to zero density on Resolution Island should be the medium- to long-term aim. Control of deer on Resolution Island would be assisted by a reduction in the potential for deer to swim to Resolution Island from adjacent parts of the mainland or other islands. The major islands in Dusky Sound (Anchor, Indian, Long, and Cooper islands) have potential as a buffer of deer-controlled islands that if successfully maintained, should reduce dispersal of deer to Resolution Island from the south.

***Action 1*:** Continue/complete deer eradication operation on Resolution Island, OR Subject to ongoing review, abandon eradication as the primary objective for deer control on Resolution Island, and adopt alternative objectives for managing deer on Resolution Island, e.g.

- Continuous control to maintain deer at low abundance on Five Fingers Peninsula
- Continuous control to maintain deer at low abundance across the whole island

***Action 2*:** Undertake deer control in buffer areas with the aim of reducing reinvasion risk. This is likely to be required on adjacent areas of the mainland, Indian Island, Long Island, and Cooper Island.

***Action 3*:** Undertake regular surveillance for deer on islands (e.g. Parrot Island, Indian Island) where deer have been controlled to zero densities, so as to detect any reinvading deer and respond with appropriate deer control.

***Action 4*:** Maintain a spatially explicit database of deer control and surveillance data and review annually to refine deer control operations.

Objective 4: Undertake ongoing stoat control in the buffer zones of all islands where stoats have been eradicated or are being maintained at zero density, to reduce reinvasion risk.

***Explanation*:** Controlling stoats in the buffer zones of islands where stoats have been eradicated or are being maintained at low density is important to reduce reinvasion risk, and would also benefit populations of indigenous fauna (e.g. southern Fiordland tokoeka) that are capable of persisting in the presence of low densities of stoats. Given the rugged nature and extensive area of adjacent mainland habitats, aerial 1080 drops targeting possums and rodents could result in effective control of stoats through secondary poisoning. Regular aerial 1080 drops also have the potential to significantly benefit indigenous vegetation and fauna that are affected by possums and rodents.

***Action 1*:** Control stoats to zero or low density on Long Island and Cooper Island.

***Action 2*:** Undertake aerial 1080 drops every three years, or in relation to masting events on areas of the mainland adjacent to Resolution Island and Indian Island. If acceptable to stakeholders, this could be extended to Long Island and Cooper Island.

Objective 5: Investigate the feasibility of eradicating pest species from islands where the benefits of eradication outweigh those of control or status quo management, by 2016.

***Explanation*:** There are several large and a number of smaller islands where the ability to eradicate pest species and successfully prevent reinvasion, or detect and remove all reinvading individuals, could be tested or validated at lower cost/lower risk than Resolution Island. These islands have reduced pest suites compared to the mainland, and a number contain ecosystem and biodiversity values that could be measurably enhanced by pest control. Beneficial outcomes would be correspondingly smaller, but still likely to be worth pursuing. For example, Long Island and Cooper Island are relatively large so could potentially support indigenous fauna with larger home ranges, and Oke Island is part of an Important Bird Area. Potential actions for these islands are listed below.

***Action 1*:** Investigate feasibility of eradicating mice from Entry Island, Parrot Island, Pigeon Island, Resolution Island and surrounding islets by July 2014.

***Action 2*:** Improve knowledge of invasion dynamics of mice, ship rats, Norway rats, stoats, and red deer in Dusky Sound through analysis of pest capture and control and observational data, on an ongoing basis.

***Action 3*:** Assess the feasibility of eradicating all pest animals from Long and Cooper Island by July 2005.

***Action 4*:** Review other pest-eradication opportunities on Dusky Sound Islands, especially as knowledge, technologies and methods improve.

Objective 6: Ensure all pest control operations that take place in the Dusky Sound area are assessed against current information regarding potential non-target effects on long-tailed and short-tailed bats.

***Explanation*:** Long-tailed bat populations throughout New Zealand are in decline (Pryde *et al.* 2005, Pryde *et al.* 2006). It is likely that similar declines are occurring for short-tailed bats. Declines appear greatest in years when numbers of their predators (rats and stoats) are highest (Pryde *et al.* 2005). Both short-tailed and long-tailed bat declines have been reversed when predator control operations that target rats have taken place (O'Donnell *et al.* 2010).

The limited bat surveys that have taken place in the Dusky Sound area did not detect bats (Hannah Edmonds, Department of Conservation, pers. comm.). However, surveys that do not detect bats do not confirm their absence. New populations of short-tailed bats are difficult to detect because of extremely low detection rates away from roosting areas (O'Donnell *et al.* 2006) and because their calls are low intensity (Borkin and Parsons 2010). Consequently, bat populations may persist even where they are not detected during multiple surveys (Borkin and Parsons 2010). Bats are susceptible to poisoning either directly by bait consumption or indirectly via the consumption of invertebrates that have fed on toxic baits (Gillian Dennis, Massey University, pers. comm.). This should be taken into account wherever bats may be present and toxins are used for pest control.

***Action 1*:** Assess current and future methods used for pest control operations in the Dusky Sound area against the most current information on potentially adverse non-target effects on short-tailed bats and long-tailed bats. The use of toxins to control pests will require adherence to Department of Conservation Performance Standards for the pesticide uses applied. These standards are set by the Department of Conservation Pesticides Advisory Group and revised as current knowledge, including the potential non-target effects on short-tailed bats and long-tailed bats, is improved. Each operation should be reassessed yearly or as standards are updated.

***Action 2*:** If bats are detected within the project area, evaluate their protection requirements and ensure that protection is sufficient to maintain bat populations in this area. At the time of writing, predator control operations that intend to protect bats should have the aim of reducing the rat population (O'Donnell *et al.* 2010).

Objective 7: Establish short-term and long-term monitoring of vegetation condition, using existing baseline data were possible.

***Explanation*:** Monitoring of vegetation condition is important as an outcome indicator of deer control, and to assess potential rates of vegetation change that can be used in conjunction with mapping of vegetation to determine habitat condition for indigenous fauna over time. This information can be used to justify pest control and to determine the feasibility of translocations and reintroductions of indigenous fauna. Baseline monitoring should be undertaken at an early stage so that later reassessment enables the benefits of control operations to be fully documented.

Permanent vegetation plots are the most informative and widely comparable method for long-term monitoring of vegetation structure and condition. They allow

quantification of structural changes and the data generated from plots can be used to define vegetation units objectively. Woody species should be counted or measured (sapling counts within height classes; diameter at breast height for trees) whereas the cover of non-woody species is most easily assessed by visual estimation. Nine permanent 20 m × 20 m vegetation plots have already been established on Anchor Island (Ewans 2010).

Seedling ratio index (SRI) surveys are a rapid monitoring technique that should provide early information on the recovery of palatable forest tree species. SRI transects should be established in areas where deer use is high, e.g. low elevation, relatively productive sites. They are not suited to long-term monitoring of forest health, but should complement data collected from long-term forest monitoring plots. Twenty SRI transects have been measured in the northwest of Resolution Island (Ewans 2010).

***Action 1*:** At least fifty long-term vegetation monitoring plots are established by 2014 in forest and grassland/herbfield habitats in susceptible vegetation where deer control is undertaken, or planned to be undertaken, within the project area.

***Action 2*:** Remeasure all long-term monitoring plots after five years and analyse and interpret plot data and report on vegetation changes by 2020.

***Action 3*:** Establish seedling ratio index surveys in 2013 in deer-preferred forest habitats in all areas where deer control is undertaken.

***Action 4*:** Remeasure existing SRI transects in November 2013 and report on vegetation changes by July 2014.

***Action 5*:** Remeasure new SRI transects within four years of their establishment and report on vegetation changes within six months of obtaining remeasurement data.

***Action 6*:** Critically review vegetation monitoring outcomes and methodology and report on the outcomes of the review in 2021.

Objective 8: Control gorse within the project area on an ongoing basis, and develop and implement weed biosecurity and surveillance protocols by July 2014.

***Explanation*:** Gorse is the only notable terrestrial weed of conservation concern in the project area. It is present at several sites at low density and has the potential to increase further at coastal sites if not controlled. Gorse seed is very long-lived and newly establishing plants can flower after 2-3 years of growth, so gorse control at existing sites need to be revisited on an annual basis. Biosecurity protocols should be established and implemented, particularly for islands that have few or no weeds at present. This should include developing a weed risk assessment for the project area. Surveillance for gorse, and other significant ecological weeds, should be undertaken on a regular basis.

***Action 1*:** Map all sites where gorse is known to have established in the project area.

***Action 2*:** Carry out annual inspection and if necessary, control of gorse, at all known coastal sites, and at other coastal sites susceptible to gorse invasion.

***Action 3*:** Develop and implement a weed biosecurity plan by July 2014, including a weed risk assessment for the project area.

***Action 4*:** Undertake regular surveillance for gorse and other significant ecological weeds within the project area on an ongoing basis, and undertake control when detected.

***Action 5*:** Report annually on weed control and surveillance activities.

7.2 Goal 2: Translocations and terrestrial biodiversity information

7.2.1 Habitat mapping

All translocations would be better informed by accurate information on the extent of different vegetation/habitat types within the project area.

Objective 9: Develop a management-informative mappable vegetation/habitat classification for the project area by July 2014.

***Explanation*:** Currently there is no adequate vegetation mapping layer for the project area. National land cover databases, such as the Land Cover Database Version 3, do not provide sufficient discrimination of vegetation/habitat types and are subject to errors of classification and resolution. Vegetation/habitat mapping would allow quantification of the areas of different vegetation/habitat types on each island, which is important information for the evaluation of the potential of islands as habitat for indigenous fauna, and for stratifying monitoring effort for pest animals. Vegetation maps are particularly needed for Resolution and Anchor Islands, which are proposed for number of translocations of indigenous fauna. Long Island and Cooper Island are other large islands that warrant vegetation/habitat mapping to assist the evaluation of fauna translocation proposals. A mappable vegetation/habitat classification should be developed initially, so that mapping units are consistent between different islands. Mapping units should be management informative (e.g. units include those habitats required by potentially reintroduced indigenous fauna) rather than aiming to map every different vegetation type. Mapping should be completed within a GIS, to enable calculation of mapping unit areas.

***Action 1*:** Use existing data (vegetation plots, reports on vegetation) to develop a mappable vegetation classification for the Dusky Sound project area by July 2015.

Objective 10: Use the vegetation classification to progressively map vegetation and habitats on islands greater than 4 ha in size (and other areas if required by other objectives) within the project area by 2020.

***Action 1*:** Use existing data (vegetation plots, reports on vegetation) to map the classification on Resolution and Anchor Islands by 2015.

***Action 2*:** Map vegetation and habitats of Long Island and Cooper Island by 2016.

***Action 3*:** Undertake timely vegetation and habitat mapping as required by the information requirements of other objectives, particularly those relating to translocation of indigenous fauna (e.g. Objective 16 relating to takahe habitat).

***Action 4*:** Complete vegetation mapping on all islands greater than 4 ha in size by 2020.

7.2.2 Avifauna translocation priorities

Translocations are a key focus of avifauna objectives. Numerous species have been proposed for translocation in the Anchor Island and Resolution/Secretary Island restoration plans (Edmonds 2002; Wickes and Edge 2012). These species are included in the following objectives and discussion, as are others that should be considered. Table 11 assesses the potential species according to a number of measures in order to clarify issues and develop a priority translocation list.

The measures in Table 11 are given a score which is used to rank the species for translocation (Table 12). The measures and their scores are described below:

- Threat classification. Threatened-Nationally Critical (9,10); Threatened-Nationally Endangered (7,8); and Threatened-Nationally Vulnerable (5,6) - the higher numbers in each category are given to species in decline, and the lower numbers for species that are increasing or stable (from Miskelly *et al*. 2008). At Risk-Declining (4); all other At Risk categories (2); Not Threatened (1).
- Importance for restoration of ecosystem processes. Every species in Table 11 is likely to have once been present within the Dusky Sound project area, and consequently, each is an integral component of the pre-European functioning ecosystem. A small number of species, however, can be considered of greater importance to the restoration of ecosystem processes, particularly seed dispersal, pollination, and nutrient cycles. These species are scored (5) and all others are not scored.
- Habitat availability. Assessed over all islands within the project area, whether they are presently suitable or not (i.e. require pest control). High (10), Medium (5), Low (1).
- Can coexist with the following pests. Allowance is made where it is not clear whether species may be able to coexist with mice or stoats. None (0); Mice? (2); Mice (4); Mice, low stoats? (6); Mice, low stoats (8); Mice, rats, low stoats (10).
- Other significant risks and issues. Scored out of (10) where 10 is no other risks (in addition to pests and habitat availability). Other risks are identified in Table 11.

Justification for these scores is given as part of the explanations of objectives that follow.

Table 11: Assessment of the potential for indigenous bird species translocations within the Dusky Sound project area.

Species	Threat Classification	Important for Restoration of Ecosystem Processes	Habitat Availability	Can Coexist with the Following Pests	Other Significant Risks or Issues	Translocation Fits With National Plan (e.g. Recovery Plan)	Recommended Islands for Translocations (In Order of Priority)
Kakapo	Threatened-Nationally Critical		High	Mice	Disease, seabird interactions, weka interactions, mice eradication, availability of birds for transfer	No, too early to consider, but possible in the long term	Resolution
Takahe	Threatened-Nationally Critical		Low	Mice, low stoats	Availability of birds for transfer, habitat in poor condition due to deer	No, too early to consider, but possible in the long term	Resolution
Shore plover	Threatened-Nationally Critical		Medium	None	Lack of existing secure translocated populations, avian predators, dispersal from translocation sites	No, too early to consider, but possible in the long term	Resolution (Five Fingers Peninsula)
Southern New Zealand dotterel	Threatened-Nationally Critical		Medium	Mice, low stoats?	No experience with translocations, limited understanding of habitat requirements	No, too early to consider, but possible in the long term	Resolution
Blue duck	Threatened-Nationally Vulnerable		Low	Mice, rodents, low stoats	Dispersal into unprotected areas	No, but would assess well if adjacent mainland under pest control regime	Resolution
Mohua	Threatened-Nationally Vulnerable		High	Mice, low stoats?	Require confirmation of success of mohua populations on islands with low stoats given demise of other species on Secretary Island	Yes	Resolution Indian Long Cooper
North Island kokako	Threatened-Nationally Vulnerable	Yes	High	Mice, low stoats?	Disease, climatic conditions, availability of birds for transfer, failure of Secretary Island population unresolved	No, if cause of Secretary Island failure cannot be confirmed	Resolution
Rock wren	Threatened-Nationally Vulnerable		Medium	None	None	No, unless suitable mouse-free locations are available	Anchor Resolution
Southern Fiordland tokoeka	Threatened-Nationally Vulnerable		High	Mice, rodents, low stoats	Potential impacts on invertebrate and lizard translocations. Competition	Yes	Cooper

Species	Threat Classification	Important for Restoration of Ecosystem Processes	Habitat Availability	Can Coexist with the Following Pests	Other Significant Risks or Issues	Translocation Fits With National Plan (e.g. Recovery Plan)	Recommended Islands for Translocations (In Order of Priority)
					with little spotted kiwi is unlikely to affect this species		
Sooty shearwater	At Risk-Declining	Yes	High	Mice, rodents, low stoats	High risk of failure given population decline is due to marine factors	No	None recommended
Western weka	At Risk-Declining	Yes	High	Mice, rodents, low stoats	Potential impacts on many other fauna translocations and risk of weka reaching Anchor Island	Yes	None recommended
Brown teal	At Risk-Recovering		High	Mice, rodents, low stoats	None	Yes	Resolution Anchor
South Island saddleback	At Risk-Recovering		High	Mice?	Potential impacts on invertebrate translocations.	Yes	Resolution
Broad-billed prion	At Risk-Relict	Yes	High	Mice?	Intensive, long-term effort	Yes	Small islands around Anchor Breaksea Resolution (Five Fingers Peninsula) Anchor
Little spotted kiwi	At Risk-Relict		High	Mice	Potential impacts on invertebrate and lizard translocations. Unknown impact of competition with Southern Fiordland tokoeka	Possibly - to be confirmed	Anchor Resolution Long Cooper
Mottled petrel	At Risk-Relict	Yes	High	Mice?	Intensive, long-term effort	Yes	Small islands around Anchor Breaksea Resolution (Five Fingers Peninsula) Anchor
Snares Island snipe	At Risk-Naturally Uncommon		High	Mice?	Potential impacts on invertebrate and lizard translocations.	Yes	Anchor
South Island robin	Not Threatened		High	Mice, low stoats	Failure of Secretary Island population unresolved	Yes	Resolution Indian Long Cooper

Species	Threat Classification	Important for Restoration of Ecosystem Processes	Habitat Availability	Can Coexist with the Following Pests	Other Significant Risks or Issues	Translocation Fits With National Plan (e.g. Recovery Plan)	Recommended Islands for Translocations (In Order of Priority)
Tui	Not Threatened	Yes	High	Mice, low stoats	Not entirely clear why the species has disappeared from many locations within the project area.	Yes	Dependent on current distribution and dispersal following initial translocations. Resolution Anchor Breaksea Indian Long Cooper

Table 12: Assessment of indigenous bird species for potential translocation to Dusky Sound - ranked scores for prioritisation purposes.

Species	Threat Status	Ecosystem Processes	Habitat availability	Predators	Other Risks	Total
Tui	1	5	10	8	10	34
Southern Fiordland tokoeka	5	0	10	10	6	31
Mohua	6	0	10	6	8	30
Sooty shearwater	4	5	10	10	1	30
Kakapo	9	5	10	4	2	30
Brown teal	2	0	5	10	10	27
North Island kokako	5	5	10	6	1	27
Western weka	4	0	10	10	1	25
Blue duck	6	0	1	10	7	24
Broad-billed prion	2	5	10	2	5	24
Mottled petrel	2	5	10	2	5	24
South Island robin	1	0	10	8	5	24
Takahe	10	0	1	6	4	21
Rock wren	6	0	5	0	10	21
Little spotted kiwi	2	0	10	4	4	20
South Island saddleback	2	0	10	2	6	20
Snares Island snipe	2	0	10	2	6	20
Shore plover	9	0	5	0	3	17
Southern New Zealand dotterel	10	0	5	0	1	16

The translocation of each species is also assessed against recovery plan priorities. In several cases, key experts have been contacted for comment on species assessments. This assessment is not scored.

Tables 11 and 12 should be updated as new information comes to hand, and can be used as a focus for discussion on prioritisation. Scoring may need to be changed on the basis of further debate. Importantly, this ranking method should be applied to other terrestrial fauna at such time that there is sufficient baseline information to allow evaluation of possible species for translocation. For example, long-tailed bat (South Island) and southern short-tailed bat would receive a very high rank given their likely importance as pollinators, high habitat availability, population growth potential under stoat control, and potentially few other risks.

7.2.3 Seabirds

Objective 11: Undertake an inventory of seabird breeding locations on islands within the Dusky Sound project area by July 2015.

***Explanation*:** Historically, burrowing seabirds are likely to have provided major nutrient inputs into the terrestrial ecosystems present in the Dusky Sound project area, primarily through deposition of guano, but also decomposition of carcasses and eggs (Mulder *et al.* 2011). The vast size and density of some seabird colonies means that the birds can have a major effect, not only on nutrient inputs, but also vegetation structure and composition, and other fauna including reptiles and invertebrates. The effects of widespread loss of seabird colonies on ecosystem processes are difficult to

evaluate. A better understanding of the existing diversity, size and distribution of burrowing seabird populations, and the habitats in which various species are present, will inform managers of the extent to which seabirds may re-establish on islands that have been or will be controlled for pest mammals.

The status and distribution of other seabird populations, i.e. surface-nesting seabirds (skua, gulls, terns), shags, and penguins, are also not well understood. The only species for which there is a comparatively generous amount of information is the Fiordland crested penguin, but the distribution and status of this species is also in question.

The difficulty in determining burrowing seabird breeding locations should not be underestimated, and is demonstrated by the recent discovery of the New Zealand storm petrel (*Fregetta maoriana*), once thought extinct, breeding on Little Barrier Island within 50 km of the city of Auckland. Likewise, the presence of over 700 islands within the Dusky Sound project area makes the task of inventory daunting. It is envisaged that inventory will be undertaken over many years. Information gathered will inform the refinement and/or extension of seabird IBAs in the Dusky Sound project area.

Islands that have remained pest-free since human occupation of New Zealand have the greatest likelihood of currently supporting seabird populations. However, some of the larger petrels (e.g. sooty shearwater) may be able to survive in the presence of low stoat populations. Some of the smallest petrels may be negatively affected by mice. The pest-free islands around Anchor Island (e.g. Petrel, Seal, Many, Stop, Nomans, Prove, and Passage Islands) should be an initial focus for survey to determine existing seabird status and distribution; some of these have had stoats eradicated and may no longer support seabird populations. The islands that have always been pest-free should not be used for restoration purposes. Also, reports of prions (unknown species) on the small islands at the southern end of Five Fingers Peninsula, and mottled petrels and sooty shearwaters on the Front Islands should also be investigated (reports from Kim Stevenson in litt. 1970s). Based on the outcomes of these surveys, decisions regarding seabird restoration projects can be made (e.g. which island(s), habitats, species).

A new technique that may be useful for the survey of remote islands is the use of acoustic recorders that can be located at sites of interest and set to run nightly for up to five weeks. The recorders log the calls of any species that calls within the range of the microphones. These calls can then be identified, and positive results followed up with ground surveys (Gaskin and Rainer 2013).

***Action 1*:** Establish a database for historical and future observations of seabird burrow locations, and observations of dawn and dusk movements of seabirds to and from breeding locations.

***Action 2*:** Formalise reporting of seabird observations from fishers, concessionaires, and others.

***Action 3*:** Begin an inventory of seabird populations with the survey of historically pest-free islands e.g. Stop, Nomans, Prove, and Passage Islands using remote acoustic monitoring, burrow searches, or both.

Action 4: Extend the inventory to islands that may support pest populations but have historical records of seabird populations such as the Front Islands and islands off Five Fingers Peninsula.

Objective 12: Evaluate islands within the Dusky Sound project area to undertake acoustic attraction and/or translocation of burrowing seabird populations by 2018.

***Explanation*:** The restoration of seabird populations is critical to the restoration of ecosystems within the Dusky Sound project area. However, not only is the extent to which the available habitats supported burrowing seabirds unknown, but the present distribution of seabirds is unknown. Before management decisions can be made regarding restoration of seabird populations in the Dusky Sound project area, an accurate assessment of the distribution and abundance of seabirds should be undertaken, at the very least at the sites of interest.

A further problem is determining which species can be expected to increase in the absence of mammalian pests. Some, such as sooty shearwater, are thought to be in decline due to marine factors such as changes in prey abundance due to oceanic warming, or mortality as fisheries bycatch. 'Relict' species are not thought to be in national decline, and are therefore relatively unaffected by offshore influences. These species provide the greatest opportunity for restoration work, but have relatively secure populations.

Restoration can be undertaken using 'passive' or 'active' methods, or both. Translocations (active management) involving the transfer of petrel chicks several weeks from fledging to artificial burrows have shown very promising results across numerous species (Miskelly *et al.* 2009). However, the process is lengthy and intensive, with chicks needing feeding between twice daily and once every 2-3 days (dependent on species requirements) for several weeks until fledging. The logistics required to undertake these translocations in such a remote area are clearly difficult. The passive approach to restoring seabird populations involves the use of acoustic attraction devices coupled with artificial burrows. Usually, acoustic attraction is undertaken in tandem with translocations. However, a number of projects have successfully attracted storm petrels and procellariid petrels to locations using only passive attraction techniques, both in New Zealand and overseas (Jones and Kress 2012, Sawyer and Fogle 2010). The success rates may be lower than for active translocations, and responses are likely to be slower. However, the trade-off is that costs are significantly lower, and the sound system recording can be set to play the calls of several species.

***Action 1*:** Evaluate islands surveyed for Objective 9 for burrowing seabird restoration attempts.

***Action 2*:** Evaluate Anchor Island, Breaksea Island, and Five Fingers Peninsula for potential for burrowing seabird restoration attempts, including survey for existing

populations (see Objective 11), habitat assessment, pest status, and potential conflicts (e.g. kakapo translocation).

Objective 13: Continue to assess long-term population trends of Fiordland crested penguin within the Dusky Sound project area on an ongoing basis.

***Explanation*:** Fiordland crested penguin have been monitored at three pest-free islands since 1994; Breaksea Island (pest-free, weka-free), and West and East Shelter Island (pest-free, weka resident) in Doubtful Sound. Analysis of data from 1994-2008 suggested that a decline may be occurring on Breaksea (significant at the 90% level only; Wildland Consultants 2010). Surveys since 2008 appear to confirm the existence of a decline (H. Edmonds, pers. comm.) suggesting that factors other than terrestrial pests may be responsible. However, another possibility is movement between breeding locations, or gradual movements of colonies due to habitat damage caused by the birds themselves (or other reasons). Continuing monitoring is important to demonstrate the extent of the decline, but methods need to be able to determine whether penguins are moving out of the monitoring sites (see further discussion in Wildland Consultants 2010).

***Action 1*:** Continue monitoring the two Breaksea Island breeding sites as per the modified double count method.

***Action 2*:** Repeat the distribution survey undertaken in 1991-1992 throughout Dusky Sound to assess distribution and numbers as closely as possible. Extend as necessary and document exact methods to ensure future repeatability. Repeat again every *c.*25 years. Use this opportunity to properly document the distribution and abundance of blue penguin colonies and the roosting and nesting sites of other seabird species such as shags and terns.

***Action 3*:** Encourage university zoology departments (particularly Otago) to consider student research on Fiordland crested penguin population dynamics, dispersal, and foraging behaviour.

7.2.4 All other birds

Objective 14: Establish a long-term outcome monitoring programme for key forest birds on Resolution Island in 2013.

***Explanation*:** Monitoring of the effects of stoat control and deer control on forest birds in forested habitat in the Dusky Sound project area is important for demonstrating the value of intensive pest control efforts to existing and potential stakeholders. Outcome monitoring of southern Fiordland tokoeka has been initiated on Resolution Island. Research in the Murchison Mountains (Edmonds 2012) suggests that expected increases are likely to be slow. Natural fluctuations in call count rates combined with slow increases mean that significant increases may take several decades to be detected. In contrast, increases in species such as South Island kaka and kereru are likely to be rapid.

Trapping for stoats on Resolution Island was initiated in 2008. Many species of forest birds will have already significantly increased as a result. Changes are still likely, however, and monitoring should commence as soon as possible to ensure the greatest chance of detecting change. Maintenance of deer numbers at low levels is also likely to have a positive impact on bird abundance as deer-palatable species regenerate, although this will be a much slower and less marked increase. The effects of deer and stoat control on bird populations will be confounded, meaning outcomes will not be able to be accurately attributed to the control of a specific pest. This is not particularly important but needs to be acknowledged.

Five-minute bird counts are undertaken on Anchor Island to monitor the effects of stoat control on forest birds, and have demonstrated the increases that are possible to detect (H. Edmonds pers. comm.). Establishing five-minute bird counts on Resolution Island is unnecessarily costly given the lag between stoat control and the initiation of monitoring, and the existence of the Anchor Island counts. Nevertheless, valuable data could be obtained by trapping staff who traverse the island three times per year with little extra effort. For example, staff could record all South Island kaka and kereru seen or heard, noting the nearest trap number. These species are obvious, hard to mistake, and likely to respond significantly to both stoat and deer control. Staff could also record observations of translocated species, at least until establishment is confirmed.

***Action 1*:** Continue the five-minute bird count monitoring on Anchor Island.

***Action 2*:** Develop and implement a formalised observational monitoring regime by September 2013 for South Island kaka, kereru, and other conspicuous forest bird species of interest, incorporating observations recorded by staff operating pest animal trap lines.

***Action 3*:** Report annually on bird monitoring results, including interpretation of any trends that are evident.

Objective 15: Undertake further translocations of mohua to Dusky Sound islands with low stoat populations if Resolution Island mohua population is shown to be secure.

***Explanation*:** Mohua (Threatened-Nationally Vulnerable) have a relatively long history of translocations to and within the Dusky Sound project area (Appendix 2). Mohua were introduced to Breaksea Island in 1995 where they are now thought to be at carrying capacity. From Breaksea, mohua were transferred to Anchor Island (2002) and Pigeon Island (2007). Birds from Pigeon Island were observed on Resolution Island, and a translocation from Landsborough Valley was undertaken to Resolution Island in 2011 to increase the genetic diversity of the colonising population. A further transfer from Catlins Forest to Resolution Island is planned for 2013.

Mohua were introduced to Secretary Island in 2009 and are monitored opportunistically when traps are checked (Wickes and Edge 2012; H. Edmonds pers. comm.). Recent observations indicate that the mohua population on Secretary has established and is expanding. However, the possible failure of the island's kokako and robin translocations (Willans 2013) raises the possibility that Secretary Island's

residual stoat population may still be causing population declines of vulnerable bird species. Given this possibility, the long-term sustainability of mohua translocations to both Secretary and Resolution Islands needs to be confirmed before translocations to other islands within the project area are undertaken, specifically those where stoats will be controlled to low levels rather than eradicated.

***Action 1*:** Continue with the planned translocation of mohua to Resolution Island in 2013 to bolster numbers and improve genetic diversity of the founder population.

***Action 2*:** Undertake annual monitoring of the Resolution Island mohua population in November using an appropriately designed method.

***Action 3*:** Report on the Resolutions Island mohua results on an annual basis, and provide recommendations for further translocations to Indian, Long, and Cooper Islands

The following actions can be undertaken if the mohua populations on Secretary and, particularly, Resolution Islands are shown to be secure.

***Action 4*:** Undertake one or more translocations of mohua to Indian Island.

***Action 5*:** On the basis that rat eradication is successful and stoats can be maintained at low levels on Long Island, undertake translocations of mohua to Long Island.

***Action 6*:** On the basis that rat eradication is successful and stoats can be maintained at low levels on Cooper Island, undertake translocations of mohua to Cooper Island.

Objective 16: Assess the presence of southern Fiordland tokoeka on Cooper Island by 2015, and undertake translocations by 2018 if presumed to be absent.

***Explanation*:** Southern Fiordland tokoeka (Threatened-Nationally Vulnerable) are present on Resolution, Long, Indian, and Parrot Islands (Edmonds 2002). The presence of tokoeka on Cooper Island needs to be confirmed, as the only records are historical (H. Edmonds pers. comm.).

Cooper Island and Long Island still support stoats, but stoats are largely absent from Indian Island and Parrot Island, and at low densities on Resolution Island. Controlling stoats to low densities on Cooper and Long Islands will ensure the recovery of the Long Island population, and will either protect the Cooper Island population, or create a further island for translocations of southern Fiordland tokoeka. The control of stoats on Cooper and Long Islands will establish a large and relatively secure population of southern Fiordland tokoeka within the Dusky Sound project area.

If kiwi are not detected on Cooper Island after extensive surveys, a small, remnant population may still be present. Consequently, translocations of southern Fiordland tokoeka will either establish a new population or bolster the genetics of the residual population.

Southern Fiordland tokoeka are monitored on Resolution Island using call counts. It is assumed that the population response to stoat control on Resolution Island will be similar to that on Long and Cooper Islands once stoat control is undertaken. Consequently, population monitoring on these islands is not necessary. Additionally, other bird species provide better opportunities for outcome monitoring of stoat control (see previous comments, Objective 12).

***Action 1*:** Undertake surveys for southern Fiordland tokoeka on Cooper Island.

***Action 2*:** If extensive surveys on Cooper Island do not detect kiwi, and pest control is able to maintain stoats at low levels, undertake translocations of southern Fiordland tokoeka to Cooper Island.

Objective 17: Undertake translocations of little spotted kiwi to Anchor Island by 2018.

***Explanation*:** Little spotted kiwi (At Risk-Recovering) were once widespread throughout New Zealand and Dusky Sound. The species is now restricted to a small number of offshore islands, primarily off the North island, but its population is increasing. It is the most vulnerable to predation by mammalian predators of all kiwi taxa. Prior to extinction on mainland New Zealand, little spotted kiwi coexisted with most other kiwi taxa, including northern and southern Fiordland tokoeka.

The draft island strategy for kiwi taxa identifies priorities for island translocations (Colbourne 2009). This plan lists little spotted kiwi as the third priority for island translocations behind rowi (first) and Haast tokoeka (second). Haast tokoeka are now considered to have sufficient secure island habitats, and the Dusky Sound project area is south of the natural range of rowi, and is not considered suitable (Shaw 2013). Little spotted kiwi are therefore a strong candidate for translocation within Dusky Sound.

Investigation into the suitability of Anchor Island for little spotted kiwi was undertaken several years ago with mixed results. The nature of the peaty soil was found to be associated with a relatively low diversity and abundance of invertebrate fauna. The conclusion of the investigation was that Anchor Island would only support a very small population of little spotted kiwi (Colbourne 2005). Additionally, the relatively poor habitat available would be more suitable for smaller kiwi species rather than the larger tokoeka. However, Shaw (2013) notes that other kiwi taxa have been shown to thrive in other locations with low invertebrate densities, and supports the translocation to Anchor Island "in principle". Shaw (2013) recommends that "the translocation proposal [for little spotted kiwi] presents the wider context of Fiordland Islands to demonstrate adequate long-term contingency for taxa of Fiordland tokoeka".

A second school of thought on the prioritisation of translocation of kiwi taxa to islands should be considered in relation to the Dusky Sound project area. Given the status of little spotted kiwi and southern Fiordland tokoeka, and the limited natural distribution of the latter, the protection of southern Fiordland tokoeka should take precedence within the Dusky Sound project area. Consequently, it is not recommended to establish little spotted kiwi on pest-free islands to the exclusion of

tokoeka. However, the apparent unsuitability of Anchor Island for tokoeka provides an exception, and the translocation of little spotted kiwi to Anchor Island should be undertaken. Shaw (2013) recommends using transmitters to monitor the health of a proportion of the first released birds to help determine the island's suitability, before following up with further translocations. Call counts should also be established for long-term monitoring.

***Action 1*:** Undertake one or more translocations of little spotted kiwi to Anchor Island, undertaking monitoring as per the recommendations of Shaw (2013).

Objective 18: Evaluate Resolution, Cooper, and Long Islands for the translocation of little spotted kiwi by 2018.

***Explanation*:** Little spotted kiwi only coexist with other kiwi species on Kapiti Island. Establishing two kiwi species on one or more islands within the Dusky Sound project area would be a unique opportunity to restore a situation that was once commonplace throughout New Zealand. If establishment of little spotted kiwi was shown to be possible in the presence of larger kiwi taxa (like southern Fiordland tokoeka), it would open the doors for significant increases in the number of secure islands for little spotted kiwi in Fiordland. However, the possible extent and effects of competition between kiwi species are not well understood. Introducing little spotted kiwi to islands with resident tokoeka may be problematic if the larger tokoeka are likely to outcompete little spotted kiwi. Alternatively, introducing both species to a novel island may be more likely to establish robust populations of the two species, although it remains somewhat experimental.

A number of islands provide opportunities for the establishment of both kiwi taxa. . Resolution Island has a large tokoeka population which is likely to be increasing in the presence of a residual stoat population. However, the current distribution of kiwi is patchy (Colbourne 2005), and there may be sufficient space for the establishment of a substantial little spotted kiwi population. Successful control of stoats to low levels on Cooper and Long Islands, and minimisation of stoat immigration from the mainland, could allow the establishment of both species at a stage when resident tokoeka populations may be small (or even extinct - see previous objective). This may provide little spotted kiwi a greater chance of establishing. For all three islands, results of stoat control need to demonstrate consistent maintenance of very low stoat numbers before little spotted kiwi translocations could proceed.

These opportunities should be fully investigated to determine the most appropriate. In any situation where the two kiwi taxa are present, monitoring the establishment and/or long-term population trends of both species must be undertaken.

***Action 1*:** Evaluate Resolution Island, Cooper Island, and Long Island for the translocation of little spotted kiwi including a risk analysis, further surveys on all islands (see Objective 16 for Cooper Island), and habitat evaluation.

Objective 19: Undertake translocations of brown teal (North Island) to Resolution Island by 2018.

***Explanation*:** South Island brown teal (Threatened-Nationally Critical) is now considered functionally extinct, but is still regularly seen around Chalky Island, Chalky Inlet (Andrew Smart pers. comm.). Any surviving individuals are likely to be hybrids with mallard or grey duck (O'Connor *et al.* 2007). Brown teal (North Island form; At Risk-Recovering) have been introduced successfully into Fiordland's Arthur Valley (Wickes and Edge 2012; A. Smart pers. comm.). Large numbers of brown teal are produced in captivity each year for translocations, decreasing the risk of hybridisation. Anchor Island has been suggested for translocations (O'Connor *et al.* 2007), and teal were known from the small, unnamed lake at the southwest end of the island (Kim Stevenson in litt. 1970s). However, Anchor may only support a small population; likewise Long and Cooper Islands (Andrew Smart pers. comm.).

Significantly more suitable lowland habitat is present on Resolution Island. A population on Resolution is likely to naturally colonise Anchor Island (Andrew Smart pers. comm.). Another positive factor is that brown teal have a high likelihood of surviving in the presence of very low stoat numbers. Although the species is no longer believed to be in decline (Miskelly *et al.* 2008), the recovery of brown teal is dependent on conservation efforts. Populations are present on several large pest-free islands including Kapiti and Little Barrier Island, but habitat is very limited and populations are small. The addition of Resolution Island would assist to secure the species.

***Action 1*:** Undertake translocations of brown teal (North Island) to Resolution Island.

Objective 20: Assess habitat suitability and availability for brown teal (North Island) on other islands within the Dusky Sound project area by 2018.

***Explanation*:** The Dusky Sound project area could potentially hold a large population of brown teal if pest control to sufficiently low densities could be maintained over a large enough area or assemblage of islands. An evaluation of habitat suitability would help to guide areas where pest control would be beneficial.

***Action 1*:** Assess habitat suitability and availability for brown teal (North Island) on Anchor Island, Long Island, Cooper Island and other islands if pest control has the potential to achieve low pest densities on these islands.

***Action 2*:** Prepare translocation applications for North Island brown teal to other islands deemed suitable for this species.

Objective 21: Assess changes in quality and suitability of potential takahe habitat on Resolution Island at five-year intervals from 2014.

***Explanation*:** Takahe (Threatened-Nationally Critical) were not known from Resolution Island, but were recorded on the adjacent mainland, and could have swum between the two (Wickes and Edge 2012). At present, potential takahe habitat in the subalpine zone on Resolution Island has been significantly affected by deer, and is

less productive than similar habitat in the Murchison Mountains Special Takahe Area. It is possible that after 10-20 years of maintaining deer at very low densities that Resolution Island habitat will be of sufficient condition to allow takahe to be introduced. Five Fingers Peninsula may provide alternative habitat, and is more likely to be able to be maintained at zero stoat and deer densities. However, its suitability requires a specific vegetation assessment. Given the national status of takahe, translocations to suitable, large, pest-free islands (or portions of islands) would be highly desirable, although the logistics of monitoring and ongoing genetic management of a Resolution Island population would be relatively difficult.

***Action 1*:** Undertake vegetation monitoring within the alpine zone on Resolution Island, to evaluate the suitability of the habitat for takahe.

***Action 2*:** Undertake vegetation surveys and mapping on Five Fingers Peninsula to determine suitability for takahe.

Objective 22: Determine the distribution of tui on islands within the Dusky Sound project area and assess the need for reintroductions by 2018.

***Explanation*:** Tui are absent from several islands within the Dusky Sound project area, including Resolution Island. Their demise is presumably due to predation by introduced terrestrial mammals. Tui were clearly once present as Cook described eating a tui pie during his visit to the area. Tui were also reduced to very low numbers on Secretary Island, but numbers appear to be increasing in response to pest control (M. Willans, Department of Conservation, pers. comm.)

Tui are a highly important part of forest ecosystems as they are one of the most common pollinators of flowering plants (Robertson 2013). Additionally, tui disperse the seeds of trees with medium-sized fruits (Kelly 2010). Reintroducing tui to all of the larger islands such as Resolution is therefore very important. They are able to fly long distances (up to *c.*100 km; Robertson 2013), so it is likely that tui translocated to Resolution Island would eventually spread throughout the Dusky Sound project area.

***Action 1*:** Compile information on tui distribution within the Dusky Sound project area by 2014 and undertake surveys for tui in identified gaps by 2017.

***Action 2*:** If surveys confirm that tui are absent from large parts of the Dusky Sound project area, evaluate the need for reintroduction of tui by 2018.

Objective 23: Determine the presence of weka on Long and Cooper Islands, and the adjacent Fiordland mainland by 2018.

***Explanation*:** Western weka (Fiordland) (At Risk-Declining) are one of two forms of western weka, distinguishable by plumage colour and morphology. Western weka (Fiordland; black plumage) are present in the southwest South Island, and western weka (northern South Island) on the West Coast and northern South Island. Determining the taxonomic distinctiveness of western weka is high priority objective of the western weka (Fiordland) recovery plan (Henderson and Goodman 2007). Massey University PhD research is presently addressing the taxonomic status of

weka, and is close to being finalised (T. Beauchamp, Department of Conservation, pers. comm.). This may help clarify the importance of establishing secure populations of western weka (Fiordland), and the recommendations in this plan should be revised if appropriate once the thesis is available.

Approximately 1,700 Fiordland weka are present on pest-free offshore islands, however, *c.*600 of these are present outside their natural range, and some may not be Fiordland weka (Henderson and Goodman 2007). The Fiordland weka recovery plan notes that relatively large numbers of weka are present on Secretary Island and Bauza Island (*c.*700 and *c.*200 respectively), but weka on the Seal Islands (Dusky Sound), Shelter Islands and Seymour Island (Doubtful Sound), and the Passage Islands (Chalky Inlet), are thought to each number less than *c.*100 birds (Henderson and Goodman 2007). Weka were once present on Resolution Island, but are thought to have succumbed to stoat predation (Wickes and Edge 2012). Weka were removed from Entry Island in 2008 to reduce the risk of re-establishment on Resolution. Management of the kakapo population on Anchor Island entails the trapping of weka on the Seal Islands to attempt to prevent them from colonising Anchor Island, and the active maintenance of the weka-free status of other small islands around Anchor Island (H. Edmonds, Megan Willans, Murray Willans, Department of Conservation, pers. comm.).

However, numbers on Secretary Island and Bauza Island may have been underestimated, based on the numbers of birds removed from Entry Island (Murray Willans, Department of Conservation, pers. comm.). Additionally, in January 2013, two sets of weka chicks were observed on Long Island (Pete McMurtrie, Department of Conservation, pers. comm.). Self-introduction to Indian Island and Cooper Island is therefore possible, but it is not known whether weka are present on Cooper Island (Pete McMurtrie, Department of Conservation, pers. comm.).

The local extinction of weka on Resolution Island may be a demonstration of their vulnerability to stoat predation throughout mainland Fiordland. However, the presence of a breeding population on Long Island (from where they may spread) indicates that they still have a presence within the Dusky Sound project area, though the size of the population is unknown. Surveys for weka on the Fiordland mainland would clarify the importance of establishing predator-free locations for Fiordland weka. Stoat control on Long Island would assist to secure this population. A survey to determine the status of weka on Cooper Island would enable better evaluation of the status of Fiordland weka within the project area. If weka were present to be present on Cooper Island, stoat control on Cooper Island (in addition to Long Island) would ensure a robust island population of Fiordland weka was present within the taxon's geographical range.

However, the possible presence of significant population of weka on Cooper and/or Long Islands raises issues for translocation of other fauna to those islands. Potential species introductions that could be in conflict with weka translocation include South Island saddleback, and ground-nesting birds such as burrowing seabirds, kakapo, kiwi, snipe, brown teal, shorebirds, and many invertebrates and lizards. All the bird species listed can coexist with weka, but may struggle or fail to establish in the presence of dense weka populations. However, these potential conflicts need to be balanced with the status of western weka (Fiordland) itself, and the likely ongoing

declines in unmanaged areas of the Fiordland mainland. If surveys indicate that only small, remnant populations of weka remain on one or both of Long and Cooper Islands, translocations of other fauna susceptible to weka predation may only be possible in the very early stages of recovery immediately following the initiation of stoat control, before the weka population expands.

***Action 1*:** Review objectives and actions within this plan in view of any new research regarding the taxonomy of western weka (Fiordland).

***Action 2*:** Undertake weka call count surveys on the adjacent Fiordland mainland to assess population distribution and abundance.

***Action 3*:** Undertake weka call count surveys on Cooper and Long Islands to assess presence, population distribution and abundance.

***Action 4*:** Continue to manage weka populations on the Seal Islands and other islands around Anchor Island to protect the Anchor Island kakapo population from weka predation.

Objective 24: Undertake translocations of Snares Island snipe to Anchor Island by 2018.

***Explanation*:** South Island snipe (*Coenocorypha iredalei*[1]; often called the Stewart Island snipe) was once present throughout the South and Stewart Islands. A specimen was probably killed by a member of Cook's party in 1773 in Dusky Sound (Medway 2007). This was one of the last sightings on the mainland, and it is thought to have disappeared due to the introduction of kiore. North Island snipe (*C. barrierensis*) and Forbes snipe (*C. forbesi*; Chatham Islands) also became extinct. The remaining five taxa of snipe are restricted to offshore islands; the Chatham Island snipe (*C. pusilla*), Snares Island snipe (*C. huegeli*), Antipodes Island snipe (*C. aucklandica meinertzhagenae*), Auckland Island snipe (*C. a. aucklandica*), and Campbell Island snipe (*C. a. perseverance*). Campbell Island snipe has a threat status of Nationally Critical, the Chatham Islands snipe are classified as Nationally Vulnerable, and the three other snipe taxa are classified as At Risk-Naturally Uncommon.

A draft translocation proposal has been drawn up for the release of Snares Island snipe to Anchor Island (Thakur 2011). Based on biogeography, morphology and genetics, this species is considered the best analogue for the extinct South Island snipe, and the two may best be considered subspecies of the same species (C. Miskelly in Thakur 2011). This is also the recommendation of the snipe recovery plan (Roberts and Miskelly 2003). Snipe appear to exist at lower densities at locations with mice, presumably because of competition for food. Consequently, only pest-free islands such as Anchor should be considered for snipe translocation. However, snipe are likely to be able to colonise neighbouring islands, and may establish on Resolution Island in the presence of mice. The risk of stoats occasionally reaching Anchor Island will be ongoing but is managed. The introduction of Snares Island snipe to the Dusky Sound project area precludes introduction of any other snipe taxa. Snipe may

[1] Taxonomy as per Miskelly and Baker 2009, Baker *et al.* 2010, and Gill *et al.* 2010.

compete with kiwi species but snipe and kiwi species once coexisted. Introduction of snipe prior to kiwi should enable snipe to establish (Thakur 2011).

***Action 1*:** Undertake translocations of Snares Island snipe to Anchor Island.

Objective 25: Confirm the outcomes of the Secretary, Resolution Island, and Indian Island South Island robin translocation and self-introductions by 2018, and evaluate the need for further robin translocations to other islands.

***Explanation*:** South Island robin (Not Threatened) were first translocated to the Dusky Sound project area in 1987 (Breaksea Island). Further translocations within the project area have established populations on Anchor, Pigeon Island, and most recently Indian Island in April 2013. North Island and South Island robin have been translocated a total of 50 times to various locations around New Zealand. Only half the 10 South Island robin translocations have been successful (Miskelly and Powlesland 2013). South Island robin were reintroduced to Secretary Island in 2008. Anecdotal observations during the following two years indicated that robin were breeding and their distribution on the island was expanding significantly. However, more recent observations, including annual five-minute bird counts, indicate that the population has since crashed, and is unlikely to persist (Willans 2013).

South Island robin have recolonised Resolution Island from Pigeon Island. The draft Secretary and Resolution Islands restoration plan suggests a follow-up translocation from a mainland population of robin to increase genetic diversity (Wickes and Edge 2012). In light of the likely failure of the Secretary translocation, monitoring the colonising birds on Resolution Island is important to ascertain the longevity of the potential population prior to any further releases.

***Action 1*:** Conduct specific surveys for robins on Secretary and Resolution Islands to evaluate the ability of the species to coexist with residual stoat populations.

***Action 2*:** Undertake a follow-up translocation on Resolution Island if the self-introduced population appears to be increasing.

***Action 3*:** Monitor the establishment of the new Indian Island population to determine the success of the translocation.

***Action 4*:** Evaluate Long and Cooper Islands for robin translocations if pests are eradicated/controlled.

Objective 26: Evaluate the suitability of Resolution Island for South Island saddleback translocations by 2018, and undertake a translocation if appropriate.

***Explanation*:** South Island saddleback (At Risk-Recovering) also have a long history of translocations within the Dusky Sound project area. Birds were taken from Big Island and Kundy Island in 1992 and transferred to Breaksea Island. A translocation from Breaksea has seen a population establish on Anchor Island. Despite being present on numerous pest-free islands around the South Island, the population of

South Island saddleback still numbers only *c.*650 individuals due largely to the small size of the islands. Translocation to larger islands within the project area (such as Resolution Island) will enable the population to increase further, and could assist in removing the subspecies from the At Risk threat classification list.

However, South Island saddleback are particularly vulnerable to terrestrial predators including rats and stoats and do not presently coexist with mice (consequently the potential impacts of mice are not known). Additionally, the ability of a population to expand in the presence of weka may be reduced (Roberts 1994; Wickes and Edge 2012). Nevertheless, in light of the relative security of existing island populations, the Saddleback Recovery Group considers that the need for larger island populations outweighs the potential impacts of weka and mice (Wickes and Edge 2012). Saddleback could therefore be considered for translocation to Resolution without mouse eradication, assuming low numbers of stoats can be maintained.

Saddleback translocations may conflict with future invertebrate and lizard introductions as members of these groups are food items of saddleback.

***Action 1*:** Assess the suitability of Resolution Island for South Island saddleback translocations based on an assessment of the status of the remnant stoat population.

***Action 2*:** Undertake translocations of South Island saddleback to Resolution Island if the assessment deems this appropriate.

Objective 27: Confirm the outcome of the Secretary Island kokako translocation through a further survey in 2013.

***Explanation*:** North Island kokako (Nationally Vulnerable) are an analogue species for South Island kokako, which was once present in the Dusky Sound project area, but which may now be extinct. Kokako are able to consume fruits with large and moderate-sized seeds, and also visit indigenous flowers. Consequently, they are likely to have once been an important seed disperser and pollinator in New Zealand forests (Kelly *et al.* 2010). Consequently, reintroducing kokako to Dusky Sound islands would be a valuable component of the restoration of forest ecosystems within the project area.

Twenty-seven North Island kokako were introduced to Secretary Island, Doubtful Sound, in 2008-2009. By 2011, six of the transferred kokako had been observed, and an unbanded juvenile was detected, indicating breeding. However, a thorough survey in 2013 found no kokako, and the translocation is assumed to have failed (Willans 2013). Willans (2013) reports that the most likely reasons for the failure include stoat predation, founder population demographics (birds were sourced from three populations and may have not intermixed due to dialectical differences), and founder population size. Climatic differences and habitat suitability were not thought to be likely causes of failure.

The possible failure of the translocation should be confirmed via further surveys for kokako on Secretary Island. Territorial kokako are sometimes unresponsive to playback and can remain unobserved for several seasons, and the Secretary birds may yet be found. However, if the translocation is found to have failed, further

translocations to Secretary or any island within the Dusky Sound project area are unlikely to be sanctioned by the Kokako Recovery Group without a good understanding of why the introduction did not succeed (J. Innes pers. comm.).

Resolution Island may provide better habitat for kokako than Secretary Island (i.e. larger expanses of more productive lowland forest with fewer geographical barriers). If kokako are found to be surviving and breeding on Secretary in numbers large enough to warrant further investment, further translocations to secure this population should take precedence over any introductions to Dusky Sound. However, if planned surveys and opportunistic observations (e.g. via pest control staff) indicate that the translocation has failed, and the cause of failure is clearly understood, priority for any further translocations could shift to Resolution Island. Resolution Island should be considered when trapping outcomes demonstrate that the stoat population can be maintained at very low levels.

The 2012 revision of the threat classification for birds has removed South Island kokako from the extinct list (Megan Willans pers. comm.). This revision has yet to be formally released. The reasons for the change in status are unknown, but the recommendations of this plan may need to be reviewed in light of this most recent decision.

***Action 1*:** Carry out an additional survey in 2013 to assess the Secretary Island kokako population.

***Action 2*:** If the Secretary Island kokako translocation has failed, and the cause of the failure is known, evaluate Resolution Island as a potentially suitable alternative for future translocations.

Objective 28: Reassess the possibility of translocations of rock wren to the Dusky Sound project area by 2018.

***Explanation*:** Rock wren (Nationally Vulnerable) were once present on Resolution Island, but it is not known if other islands in the project area, including Secretary, also supported populations. Rock wren were introduced to Anchor Island in 2004-2005, but this transfer failed, possibly due to birds being moved at less than ideal weights and limited habitat availability. Translocations to Secretary Island from 2008-2010 appear to have resulted in the rapid establishment of a healthy population; preliminary data from a survey in 2013 identified a minimum of 60 individuals of which only three were part of the original transfers (Willans 2013). On average, the rock wren released on Secretary Island were 3.8% heavier than the birds released on Anchor Island (Willans in prep. 2013). This is not a significant difference; however, it may impact on survival for a bird of this size. A significant difference between these two translocations was the timing of the transfer. The first translocation was undertaken in the months of December/January after chicks had recently fledged, and the second during the months of March/April during and after the phase of juvenile dispersal (Megan Willans pers. comm.).

Suitable subalpine habitat is present on Anchor Island, but may be insufficient for successful establishment. Habitat also needs to be quantified on other islands, in particular, Resolution, Long and Cooper islands Rock wren are susceptible to

predation by mice, and may not be able to be reintroduced to Resolution, Cooper and/or Long Islands unless mice can be eradicated or maintained at low densities. The eradication of mice from these islands may be impossible due to their large size in conjunction with small mouse home ranges.

***Action 1*:** Reassess the failure of the Anchor Island translocations, and if the likely cause for failure can be confirmed, undertake further translocations to the island.

***Action 2*:** Assess Resolution Island, Cooper Island and Long Island for suitable habitat for rock wren. If mice can be eradicated from either island, and sufficient suitable habitat is present, undertake translocations.

Objective 29: Reassess the possibility of translocations of shore plover to the Dusky Sound project area in 2023.

***Explanation*:** Shore plover (Nationally Critical) was described from specimens taken from Dusky Sound in 1773 during Cook's visit. Dowding and O'Connor (2013) have recently summarised all translocations of shore plover, and the following is taken from their paper. Shore plover breeding habitat at their last remaining natural location (South East Island) consists largely of rock platforms. However, outcomes from translocations indicate that shore plover are much less specific in their breeding and foraging requirements than previously thought. Sandy beaches may in fact be a key habitat. A range of coastal habitats is available on Resolution Island as well as other neighbouring islands. Five Fingers Peninsula, in particular, has extensive areas of suitable habitat and is potentially stoat-free and can be maintained at close to zero stoat density.

However, numerous issues are associated with the translocation of shore plover. Translocations indicate that shore plover can survive and increase in the presence of mice, but their susceptibility to very low numbers of stoats is unknown. Two translocated island populations with increasing populations have recently been decimated by possible rodent invasions (Dowding and O'Connor 2013). Low numbers of stoats may have a greater impact (J. Dowding pers. comm.). Translocations of the species have also demonstrated the species' vulnerability to avian predation, including by morepork, southern black-backed gull, red-billed gull, Australasian harrier, and possibly others. Most of these species, perhaps apart from morepork, are likely to be at low levels on Resolution Island. Translocations of shore plover are further complicated by high levels of dispersal, particularly juveniles, the reasons for which are still unclear. Translocations require portable holding aviaries to be established on site, and are likely to require ongoing releases to ensure a breeding population establishes. Critical issues include the fact that few translocated populations are self-sustaining and none are known to be secure (Dowding and O'Connor 2013; J. Dowding pers. comm.).

In 2003, Chalky Island was assessed for suitability for shore plover translocation. Concerns included possible stoat invasion by stepping stone islands, a large population of fur seals (potential crushing of nests and small chicks), New Zealand falcon predation, and the logistics and cost of monitoring (J. Dowding pers. comm.).

In summary, the positive outcomes of shore plover translocation to Dusky Sound, including returning shore plover to its type locality, and further securing the species, are presently outweighed by potential risks. Risks could be reduced by demonstrating the stoat-free nature of Five Fingers Peninsula (e.g. 10 years of no stoat captures), and the presence of low populations of avian predators. However, given that no existing translocated populations are both self-sustaining and secure, the recovery group will only be considering predator-free release sites for the foreseeable future (J. Dowding pers. comm.).

***Action 1*:** Reassess the possibility of translocating shore plover to Five Fingers Peninsula in 2023 based on the national status and security of the species and the status of the remnant stoat population at both the release site and elsewhere on Resolution Island.

Objective 30: Reassess the possibility of translocations of southern New Zealand dotterel to the Dusky Sound project area in 2023.

***Explanation*:** Southern New Zealand dotterel (Nationally Critical) was also described from Dusky Sound in 1773. The species was once widespread throughout the South Island, but is now restricted to Stewart Island where, under intensive pest control, its population increased from 62 to *c.*250 in approximately 13 years (Dowding and Davis 2007). Dowding (1999) completed a thorough analysis of historical records and concluded that the subspecies bred inland, that its demise was probably due to introduced predators, but that this inference was problematic given the survival of the North Island subspecies in similar conditions. His conclusion was that reintroductions would not be possible until widespread control of mustelids and feral cats was possible. The subspecies once bred in lowland South Island, but the breeding habitat of the remnant population on Stewart Island is mainly subalpine herb-field and rocky areas (Dowding and Moore 2006), possibly not reflecting the subspecies preferred habitat and/or the range of potential breeding habitats. Nevertheless, this habitat is superficially similar to habitat available on Resolution Island, but needs to be assessed. Given the dotterel's tendency to disperse widely during breeding, habitat availability on Resolution may be restrictive. Overall, translocation is high risk given the very small existing population, lack of previous translocation attempts, habitat availability, lack of understanding of habitat requirements, and continuing presence of a low density stoat population.

***Action 1*:** Undertake an assessment of habitat availability for southern New Zealand dotterel on Resolution Island, particularly Five Fingers Peninsula.

***Action 2*:** If sufficient habitat is present, reassess the possibility of translocating southern New Zealand dotterel to the Dusky Sound project area, and Resolution Island in particular, in 2023. A key prerequisite will be continuing increases in the Stewart Island population, allowing for provision of individuals for translocation, the ongoing maintenance of very low stoat densities.

Objective 31: Reassess the potential for further translocations of kakapo to the Dusky Sound project area in 2023.

***Explanation*:** Kakapo (Nationally Critical) were once present throughout New Zealand but now number approximately 124 birds largely restricted to two islands, Whenua Hou (Codfish Island; introduced in 1987) and Anchor Island (introduced in 2005), with small numbers on Hauturu (Little Barrier Island; reintroduced in 2012), and males on Pearl Island and Chalky Island (H. Edmonds pers. comm.).

Kakapo can coexist with mice, but cannot be resident on islands planned for mice eradication as many birds are likely to be accustomed to feeding on supplementary food pellets and could consume poison bait. Ideally, therefore, islands suitable for kakapo reintroduction will be entirely pest-free with low risk of stoat invasion. Burrowing seabirds have proven problematic on Whenua Hou as they disturb nesting female kakapo to the extent that they neglect or accidently damage their eggs (D. Vercoe, Department of Conservation, pers. comm.). This issue is difficult to resolve given seabird populations are likely to increase on islands that are made pest-free, but means islands with sizable, existing seabird populations should not be considered for translocations. Kakapo eggs and chicks are also highly vulnerable to weka predation so there needs to be a high level of insurance that Kakapo breeding sites are, and will remain, weka free. Lastly, kakapo will only be introduced to islands where minimal monitoring is required. This means that further introductions within the project area are unlikely until the population on Anchor Island is shown to be self-sustaining, and sufficient birds are available for translocation.

***Action 1*:** Reassess the possibility of further translocations of kakapo to pest-free islands within the Dusky Sound project area in 2023 based on, in part, the self-sufficiency of the Anchor Island population and the availability of suitable pest-free islands (e.g. weka-free).

Objective 32: Reassess the possibility of translocations of blue duck to the Dusky Sound project area in 2018.

***Explanation*:** Blue duck (Nationally Vulnerable) were once present on Resolution Island, but are now locally extinct. Blue duck may not have been present on any other islands within the project area given island sizes and habitat availability. Suitable habitat may be present in waterways such as those associated with Duck Cove and Cormorant Cove, however, the carrying capacity of the habitat may be as few as 15 pairs (Wickes and Edge 2012). Juveniles can disperse widely, in excess of 50 km and, once habitat on the island is full, are likely to settle in unmanaged areas on the mainland. Consequently, these birds will be subjected to predation pressure and will have low breeding success. Stoat control in other areas of Fiordland illustrates the capacity of blue duck to recover from severe lows, and translocations in other areas of New Zealand have been successful. While low levels of stoats on Resolution Islands may not have a significant impact on a reintroduced blue duck population, this is potentially countered by available habitat being relatively restricted. In summary, it is not recommended to introduce blue duck until the area under intensive stoat control has been extended over significant areas of the adjacent mainland.

***Action 1*:** Reassess the possibility of translocations of blue duck to Resolution Island, particularly if adjacent mainland areas are targeted for control of pests in an ongoing regime.

Objective 33: Reassess the possibility of translocations of orange-fronted parakeet to the Dusky Sound project area in 2023.

***Explanation*:** Orange-fronted parakeet (Nationally Critical) was once present throughout New Zealand including some offshore islands, and Dusky Sound (Oliver 1955). It coexisted with both red and yellow-crowned parakeets, but now only survives in any numbers with yellow-crowned parakeet in the South Branch, Hurunui River. Orange-fronted parakeet have been successfully introduced to Chalky Island. A translocation proposal was compiled for the release of orange-fronted parakeet to Resolution Island, Secretary Island, and Breaksea Island. However, the discovery of psittacine beak and feather disease in yellow-crowned parakeets in Fiordland in 2012 means that no further orange-fronted parakeets can be introduced to the region until the implications of the disease are fully understood. Additionally, high numbers of yellow-crowned parakeets on Resolution and Secretary Islands (which have increased after the initial hit on stoats) greatly increases the risk of competition. The small population size of orange-fronted parakeets limits the availability of birds for release. .

***Action 1*:** Reassess the possibility of orange-fronted parakeet releases to islands within Dusky Sound project area if the wild population has increased sufficiently, and the risk and implications of introduction of psittacine beak and feather disease are understood.

7.2.5 Herpetofauna

Existing Herpetofauna values over the Dusky Sound project area will be substantially protected by the pest-control and pest maintenance objectives of Section 7.2.

Objective 34: Conduct an opportunistic herpetofauna inventory of the Dusky Sound project area from July 2013, which incorporates casual observations by staff conducting management work, and the public, into a formal record keeping system with follow-up searches.

***Explanation*:** There is a need to better understand the herpetofauna and its distribution within the Dusky Sound project area to inform discussion on reintroductions, translocations and threat status. Surveys tend not to be cost-effective over heavily forested areas, or areas with difficult access and terrain, and where herpetofauna occur at low population densities (e.g. Tocher *et al*. 2005). Much of the Dusky Sound project area could be described as having these characteristics. That said, there is also a lot of coast within the project area that is relatively easier to search[1].

Over vast areas of heavily forested habitat, the most cost-effective method for conducting a lizard inventory is to enable the current "users" (observers) of Dusky

[1] Generally speaking, coastal and open grassland habitat is more cost-effective to search than forest.

Sound project area to collect information; users can be enabled through education and awareness programmes. This method has proved, by far, the most effective means of generating alpine gecko records over the lower half of the South Island (Tocher *et al.* 2005). As herpetofauna populations increase, surveys will become a more feasible option.

Casual observations help prioritise survey effort and therefore reduce costs; follow-up surveys can target habitat and areas with a known Herpetofauna population. Casual observations and supporting data can be included into a database and interrogated, to obtain coarse indices of herpetofauna population change. Indices can be calibrated for changes in site-usage by observers through time i.e. the system doubles as a coarse monitoring tool. Lizard material (tail tips, entire specimens) at times may need to be collected to ascertain species identity.

***Action 1*:** Consult relevant iwi and hapu by end June 2014 on the issue of intermittently taking lizard voucher specimens, preferably tail tips only, from Dusky Sound project area. Consult the Department of Conservation best practice guidelines for the taking of herpetofauna vouchers.

***Action 2*:** A simple herpetofauna database-of-sightings is set up[1] by end June 2014; gate-keeper identified (data-champion), database is promoted internally and externally, including communication pathways (lizard identification, email contact person).

***Action 3*:** Department of Conservation staff and public "lizard-sighting" capacity is improved through local workshops, printed material and in-the-field training by the end June 2015.

***Action 4*:** Advocacy material is provided to the wider public and concessionaires (hut posters[2], flyers, text for Department of Conservation website) by end June 2015.

***Action 5*:** Lizard sightings are followed-up in a timely manner by an appropriately qualified herpetologist to determine identity, abundance and habitat preferences (on-going) of the lizard sighted. Data are included into the local herpetofauna database-of-sightings and a copy to HERPETOFAUNA Bioweb.

Note: Herpetofauna actions 1-5 are not in any particular order; they are inter-related and have the same priority status.

1 DOC Te Anau already has a database of lizard sightings that could be used for this purpose.

2 Huts need not be confined to the project area; the target audience include those who only intermittently use the project area.

Objective 35: Assess potential tuatara habitat on islands within the Dusky Sound project area by 2020.

***Explanation*:** The Dusky Sound project area is within the latitudinal distribution of the historic tuatara population, but it is not certain if environmental conditions in the project area are suitable for successful incubation of tuatara eggs and production of both male and female progeny (c.f. Besson *et al*. 2011). Tuatara are highly vulnerable to predation by rodents and larger mammalian predators, but tuatara may be able to persist in the presence of low densities of mice (Don Newman, Department of Conservation, pers. comm.). Tuatara are themselves predators on other indigenous fauna. An assessment of tuatara translocation to one or more islands in the project area would need to consider potential effects of tuatara on the resident lizard and invertebrate fauna, and the effects of any pest animals on tuatara.

***Action 1*:** Assess the suitability of soil depth, type, temperature, and moisture conditions at potentially favourable sites for incubation of tuatara eggs on selected islands in the project area by 2018.

***Action 2*:** If suitable conditions for incubation of tuatara eggs are present, assess the potential for translocation of tuatara to suitable islands within the project area by 2020.

Objective 36: Implement translocations and reintroductions of suitable[1] herpetofauna species to pest-free (including mice) islands ≥20-years post-pest eradication.

***Explanation*:** It is not appropriate to translocate/reintroduce herpetofauna into areas that may already have sister, or closely-related species (for fear of hybridisation and subsequent loss of genetic material). Also, for the purposes of this report, species with no known historic associations with the Dusky Sound project area were not considered as suitable translocation candidates (e.g. Te Kakahu skink from Preservation Ecological District).

The Department of Conservation lizard/frog Technical Advisory Group (TAG) advises practitioners to wait at least 10-years post pest-eradication before initiating translocations or reintroductions of herpetofauna species; by this time resident species should have been detected if they are present.

This TAG "rule-of-thumb" may not be applicable to the heavily forested lizard habitat of the Dusky Sound project area, where prevailing weather and the difficulty of herpetofauna-searching makes 10 years too short a time-frame. This coupled with the notion that lizards may have speciated on even the smallest islands (e.g. the Te Kakahu skink on Chalky Island), requires a super-cautious approach to lizard translocations and reintroductions over the Dusky Sound project area. Rather, a "*stand back and wait to see what turns up*" approach is more sensible and well

[1] Defined by the DOC lizard/frog TAG or equivalent panel. Based on current information, tuatara would not be suitable candidates for the Dusky Sound project area, but this should be revisited as new information comes to hand (e.g. research into soil temperatures at nesting sites on pest-free islands; see Besson *et al.* 2011).

justified here than in other parts of New Zealand. This concept is especially relevant for geckos, which can be extremely difficult to find if present in low densities, but may not hold so well for diurnal skink species residing in open and/or coastal areas which have been subject to repeated searches by herpetologists.

For translocations and reintroductions to be considered for a given island, the island would ideally meet the following criteria:

(a) Be ≥20-years post-pest eradication (including mice);

(b) Have been subjected to an adequate herpetofauna-search effort, thought to be sufficient to detect, or not, resident herpetofauna;

(c) The island is of medium-small size and/or has a non-complex habitat range. This criterion seeks to lessen the risk of the receiving site harboring undetected herpetofauna (irrespective of the search effort being judged as adequate in b. some lizards are very elusive).

(d) The island has a low pest-reinvasion risk, with an on-going commitment to biosecurity management (see in particular section 7.2, Objective 4, Action 1).

***Action 1*:** From 2033, consider translocation and/or reintroduction of suitable herpetofauna species to islands that meet Criteria a-d.

Objective 35: Undertake targeted herpetofauna surveys[1] on islands where restoration activities, such as weka reintroductions, can result in a significant adverse effect on resident herpetofauna.

***Explanation*:** Cryptic herpetofauna may be present on some islands and may be adversely affected by reintroductions or translocations of other species, e.g. predators of lizards (e.g. weka). Undertaking targeted lizard surveys on these islands would provide better information with which to evaluate their use as potential translocation sites.

***Action 1*:** Engage an appropriately qualified herpetologist to undertake a targeted herpetofauna survey on any island subject to restoration activities which could result in a significant adverse effect on resident herpetofauna.

7.2.6 Bats

Objective 36: Determine the presence of bat populations within Dusky Sound by 2017.

***Explanation*:** It is currently unknown whether either the short-tailed bat or the long-tailed bat are present within Dusky Sound. To date there has been limited survey

[1] A targeted herpetofauna survey is defined here as one that targets a particular herpetofauna species, or set of species, that is/are perceived to be at *significant risk* should a restoration action proceed at the site. The goal of a targeted herpetofauna survey is to assess the current status of the herpetofauna species and predict the likely impacts and likely outcome for the species of the restoration activity of concern. "Significant risk" can be determined in consultation with the DOC lizard/frog TAG.

effort. As both bat species are vulnerable to predation by rats, stoats, cats, and possums areas where they are most likely to persist are areas where potential roosting habitat coincides with predator management. Consequently, when surveys are planned areas should be initially targeted that contain potential roosts, old-growth cavity-bearing trees (O'Donnell *et al.* 1999, Sedgeley and O'Donnell 1999), and that are either considered predator-free or are undergoing pest control or pest management is planned.

To achieve this objective reporting of opportunistic sightings should be encouraged by the provision of advocacy materials to users of the Dusky Sound area, and targeted surveys using automatic bat detectors begun.

***Action 1*:** Advocacy material is provided to the public and concessionaires (posters, flyers, text for Department of Conservation website) by end June 2015.

***Action 2*:** Surveys using automatic bat detectors targeting both long-tailed bats and short-tailed bats begin 2013-2014. These surveys should take place in spring and summer and focus on areas of edge habitat for long-tailed bats and areas >200m into the forest interior for short-tailed bats (O'Donnell *et al.* 2006). Surveys should initially focus on sites that are considered pest-free and have old-growth cavity-bearing trees that may be chosen as roosts by either bat species.

Objective 37: Consider translocation of short-tailed bat and long-tailed bat to suitable habitats if bats remain undiscovered within the Dusky Sound project area past summer 2017-2018.

***Explanation*:** The nationally endangered short-tailed bat (Southern lesser short-tailed bat, *Mystacina tuberculata tuberculata*) and the nationally critical long-tailed bat, (South Island long-tailed bat, *Chalinolobus tuberculatus*) are those species most likely to occur within the Dusky Sound area. Both of these bats have few known populations (O'Donnell *et al.* 2010). The South Island long-tailed bat has no known populations that are currently on pest-free islands (O'Donnell *et al.* 2010). The presence of relatively large pest-free areas within the Dusky Sound area would provide a possible release site for bats within this area. At the time of writing, translocation methods for bat species are still being developed, however by 2017 these may be available.

***Action 1*:** Review bat survey results and report on the review outcome by March 2018.

***Action 2*:** If short-tailed bat or long-tailed bats are not detected during these surveys, critically assess their potential for bat translocations to the Dusky Sound area by 2019.

7.2.7 Freshwater habitats

Objective 38: Complete a targeted survey of freshwater fauna within the Dusky Sound project area by 2018.

***Explanation*:** The Dusky Sound project area, which extends from the mountains to the sea, is likely to contain one of the least modified and best preserved freshwater

systems in New Zealand. However, current records for the freshwater fauna (nine fish species and koura), appear to be clustered near anchorages in more frequently visited sites, with few records obtained from further inland. Several low gradient waterways within the project area, including the Seaforth River and its tributaries, are un-surveyed or poorly surveyed (Appendix 5). In addition, only 14 survey cards have been filled out from 2008 to present, with the remaining 45 cards filled out prior to 1986. An up-to-date inventory is required to inform decision making on freshwater values.

***Action 1*:** Complete a systematic survey of freshwater streams and rivers within the project area by the end of 2018. Initially concentrate on un-surveyed areas (particularly northern tributaries of Breaksea Sound, including Vancouver Arm and Broughton Arm; tributaries of the upper Wet Jacket Arm; and all upper reaches of waterways (>1 km from the coast), including the major waterways on Resolution Island) and areas where the only records are more than 25 years old (Lake Mike and tributaries, False Lake tributary, tributaries of Stuck Cove, Sportsmans Cove, Pickersgill Harbour, Detention Cove, Cormorant Cove, and Duck Cove, streams and lakes on Anchor Island, Cook Stream, Shag River, lower Seaforth River, and Henry Burn).

***Action 2*:** Enter all survey data into the New Zealand Freshwater Fish Database.

***Action 3*:** Report on the survey results in 2019.

Objective 39: Prevent introduction of aquatic pest plants such as didymo.

***Explanation*:** Unmodified waterways within the project area are at risk from invasion of aquatic weed species, including didymo (*Didymosphenia geminata*). Didymo has been recorded in eastern Fiordland (Waiau River, Wairaurahiri River mouth, Lake Hauroko, Lake Monowai, Lake Te Anau, and Lake Manapouri), and could be transported to the project area on contaminated fishing equipment. Most waterways within the project area have a medium-high risk of didymo establishment, although there are scattered sites with medium risk, and high risk waterways including the Seaforth River and smaller streams on Resolution Island and in Breaksea Sound (Kilroy *et al*. 2005). The project area lies within the Fiordland Rivers Sports Fishing Control Area where a Sports Fishing Licence and a Gear Cleaning Certificate are required. Department of Conservation undertakes some didymo distribution surveys within Fiordland (Duncan 2007). There are currently no control methods for didymo, so actions rely on preventing invasion and, if present, preventing spread.

***Action 1*:** Monitor aquatic systems with medium to high risk for didymo establishment within the study area on an annual basis. MAF Biosecurity New Zealand sample collection and analysis protocols should be followed.

***Action 2*:** Encourage/provide education for opportunistic monitoring of low risk waterways by staff engaged in other management activities.

***Action 3*:** Educational/prevention information (such as the Didymo Controls for Fiordland National Park sheet) is clearly visible in Dusky Track huts, management bivvies, and at access points, and held by all concession holders, by end June 2014.

7.2.8 Terrestrial invertebrates

Objective 40: Obtain quantitative information on the distribution and abundance of indigenous beetle and moth fauna within the Dusky Sound project area by 2015.

***Explanation*:** Terrestrial invertebrates in the Dusky Sound project area are indicators of habitat condition and provide important food resources for other fauna. An assessment of indigenous invertebrates is important both to document baseline invertebrate condition and to provide information on food sources for insectivorous birds that may be translocated to the project area. The general lack of information on terrestrial invertebrates in the Dusky Sound area, both in terms of species richness and abundance, hinders their direct management and makes it more difficult to ascertain the potential for translocations of their indigenous predators such as bats, birds and lizards. These problems could be remedied by gaining a more comprehensive knowledge of the indigenous invertebrate species present as well as their ecology and population trends. Repeating the survey would provide information on trends in the condition of the invertebrate assemblage over time.

Large-bodied beetles and moths form useful indicators of invertebrate health as the taxonomy of both groups is well known and they are readily trappable. Pitfall traps and hand-collecting should be used for beetles, and light trapping for moth species using standard trapping techniques (e.g. Barratt and Patrick 1987). Trapping should be done over one summer season between September and May for coastal and lowland sites, and between November and March for alpine sites.

***Action 1*:** Undertake a baseline survey in representative coastal shrubland, forest and alpine communities on Resolution Island, Anchor Island, and other islands selected in consultation with invertebrate experts, for large-bodied beetles (particularly weevils, stag beetles and carabids) and moths (particularly geometrids and noctuids) in the 2013/2014 season.

***Action 2*:** Report on the results of the baseline survey by 2015.

***Action 3*:** Repeat the baseline survey five years after the initial survey, and interpret the results of the two surveys in a report published by 2020.

Objective 41: Assess the response of indigenous invertebrate communities to different pest assemblages within the Dusky Sound project area by 2020.

***Explanation*:** The future of all indigenous invertebrate populations in the Dusky Sound project area is closely bound up with the health of the various indigenous plant communities and their constituent species, indigenous fauna communities, and the degree to which they experience predation by mammalian predators. Overall, many threatened, rare, and common indigenous invertebrates should become more abundant on pest-free islands and where pests are held at low levels, particularly large species, flightless species, and species with flightless females. However the extent to which individual terrestrial invertebrates will benefit from pest control operations is not

known. If mouse predation increases due to a reduction in stoat numbers, then the abundance of some terrestrial invertebrate species may decrease. The Dusky Sound project area presents a special opportunity to research the response of invertebrates to different pest assemblages, as it contains pest-free islands, islands with mice and low stoat densities, islands with stoats, rats, and mice, and the mainland with stoats, rats, mice, and possums. These four different pest assemblages could comprise experimental treatments on which to base collection of data on invertebrate assemblages.

Monitoring the health of invertebrate communities could therefore provide a useful indicator of mammalian predation pressure. This could be achieved by monitoring invertebrate assemblages or individual invertebrate taxa, or a combination of both approaches.

***Action 1*:** Undertake a replicated, quantitative survey of invertebrate assemblages on islands/mainland with different pest assemblages within the project area in the 2014/2015 season.

***Action 2*:** Interpret and report on the responses of invertebrates to different pest assemblages by 2016.

Objective 42: Assess the status of *Hadramphus stilbocarpae* and *Anagotus fairburni* on Breaksea Island by 2015.

***Explanation*:** The population status of the two previously-translocated beetles should be assessed to determine whether these invertebrate translocations have been successful. There are many opportunities to undertake translocations and introductions of invertebrate taxa from geographically distant areas, but a cautious approach is required, based on the success of existing translocations, and a sound knowledge of the invertebrate fauna that is currently present.

***Action 1*:** Undertake a survey to assess the status of the knobbed weevil *Hadramphus stilbocarpae* in coastal *Anisotome lyallii* herbfield on Breaksea Island and report on the survey results by 2015.

***Action 2*:** Undertake a survey to assess the status of the flax weevil *Anagotus fairburni* on Breaksea Island and report on the survey results by 2015.

Objective 43: Improve understanding of the distribution and abundance of "*Powelliphanta*" fiordlandica on Resolution Island

***Explanation*:** The southwest Fiordland endemic land snail "*Powelliphanta" fiordlandica*, is best known from its type locality on Five Fingers Peninsula, but its distribution elsewhere on Resolution Island is not well known, with most records coming from one locality. Further survey for "*Powelliphanta" fiordlandica* is required to document the status of currently-known populations, and to better determine its distribution on Resolution Island.

***Action 1*:** Undertake additional surveys for "*Powelliphanta" fiordlandica* in 16 locations in appropriate habitat, at a multitude of altitudes in forest, on various islands

and mainland locations by 2015. These surveys could double as baseline monitoring if abundance measures (e.g. snails present per unit of search effort) are recorded for each site.

***Action 2*:** Publish a report documenting the results of the "*Powelliphanta" fiordlandica* survey by 2015.

7.1 Goal 3: Marine ecosystems, habitats, and species

7.1.1 Marine mammals

Objective 44: Improve conservation measures for bottlenose dolphins in the Dusky Sound complex by 2017.

***Explanation*:** The population of bottlenose dolphins that is resident in Dusky Sound appears to be in decline and calf survival rates are low. Information is needed to improve demographic models for this population and to improve understanding of their use of the Dusky Sound Complex. In Doubtful Sound, it has been demonstrated that vessel traffic can alter dolphin behaviour patterns. It has also been shown that Dolphin Protection Zones work well to reduce these effects. Because boat traffic in the Dusky Sound Complex is likely to increase in coming years, it is important to consider how this is likely to effect the dolphin population. Increases in large vessels are of particular concern because the sound that is generated by larger vessel engines has potential to greatly impact dolphin behaviour, especially the behaviour of dolphins with calves. The management of tourism should have a precautionary approach to contribute to the long-term wellbeing of the population. Research so far has been conducted by way of collaboration with Professor Steve Dawson at the University of Otago, Department of Marine Science.

***Action 1*:** Advocate to Environment Southland for a precautionary approach towards any increases in surface water consents including the number of vessels or number of vessel hours permitted in the Dusky Sound Complex by 2015.

***Action 2*:** Advocate for a moratorium on marine mammal viewing permits in the Dusky Complex

***Action 3*:** Assess the need for the development of further guidelines on how to operate vessels in the vicinity dolphins. Any guidelines should then be widely promulgated amongst users of the fiords. These guidelines may be the same as or based on those in Doubtful Sound.

***Action 4*:** Assess the need for these guidelines to be legislated to ensure compliance using a legal framework, and if so advocate for legislation.

***Action 5*:** Monitor the population structure and trajectory of the bottlenose dolphins in the Dusky Sound Complex, by maintaining the current collaborative monitoring programme with the University of Otago or by seeking further long-term collaborations with other researchers. Future research on bottlenose dolphins should be designed to maximise the data obtained while minimising disturbance.

Potential impacts on the population should be managed so that the population grows or is stable. If declines occur, action should be taken to develop an understanding of the causes of declines and to increase dolphin protection from threats.

***Action 6*:** Support the development of mechanistic studies to investigate potential reasons for any decline in the bottlenose dolphin population in the Dusky Sound Complex by 2015.

***Action 7*:** Support a detailed study of bottlenose dolphin habitat use in the Dusky Sound Complex with the aim of assessing the utilisation of the fiords by the dolphin population by 2017.

Objective 45: Assess the use of the Dusky Sound complex by recreational and commercial vessels and report on findings by 2017.

***Explanation*:** The level of recreational boat traffic in the Dusky Sound Complex is unknown. In recent years improvements in the design and affordability of small craft has meant that the Southern fiords are increasingly accessible to private boat owners. Recreational boat users visit the Dusky Sound Complex to enjoy wildlife and natural vistas, to hunt deer, to catch fish and shell fish including paua and to scuba dive for rock lobster. This fishing effort, combined with recreational fishing from charter vessels, is likely significant at current levels because the recovery of fished stocks observed in the Dusky Sound Complex marine reserves has not been observed in the commercial exclusion zone (Wing and Jack *In press*). Recreational boat traffic also brings with it risks regarding translocation of invasive organisms into the region, disturbance to marine mammals and harm to fragile encrusting marine organisms through anchoring. In order to decide on the best measure to mitigate these threats, it is first important to assess how recreational vessels are using the region and to develop a record of how this use is changing with time. This information should be used in addition to information on charter vessel operators when making decisions regarding the impact of boat traffic on the Dusky Sound region.

***Action 1*:** Develop a method to survey the recreational vessels visiting the Dusky Sound complex and assess recreational boat traffic (number of boats, passengers, days) by 2014. This could be with the help of Radio Operators in the Fiordland Area (Bluff Fishermans Radio, Fiordland Fishermans Radio), and/or satellite images and/or time-lapse photography of common anchorages. Historical information less than ten years old could also be used.

***Action 2*:** Use the methodology to survey recreational vessels including yachts and live-aboard motor launches visiting the Dusky Sound complex during 2014-2016. Collate information on commercial use, and report on recreational and commercial use patterns by July 2017.

***Action 3*:** Repeat the recreational vessel survey every 5 years after 2016.

***Action 4*:** Advocate to regulatory authorities and other stakeholders for the development of a compulsory vessel intentions register for the inner waters of Fiordland.

Objective 46: Advocate for a high level of caution when assessing future commercial concessions for tourist vessels in the Dusky Sound complex.

***Explanation*:** Tourist vessels including charter boats and cruise ships visit the Dusky Complex to enjoy hunting, fishing, snorkelling and SCUBA diving and to experience the unique biodiversity and wilderness values of the region. However, the accumulation of impacts associated with these activities can lead to the gradual erosion of these values to below acceptable thresholds for visitors. The noise from vessel engines, in particular large vessels, can disturb bottlenose dolphin groups, in particular groups with calves, which in this population is the most vulnerable demographic stage (Guerra and Dawson in prep.). The wash from large vessels moving through small passages is an as-yet unquantified risk to fragile encrusting invertebrates such a corals and brachiopods. Anchoring poses a great risk to undiscovered fragile encrusting marine communities. It appears that cruise ships are not subject to hull cleaning before they enter Fiordland, though they may anchor in the Dusky Complex, posing a risk for the translocation of marine invasive species. Finally, the presence of other vessel traffic, in particular large vessels or seasonally resident vessels and the associated traffic from supply helicopters can significantly impact the wilderness values experienced by visitors to the region.

***Action 1*:** Advocate for a precautionary approach towards any increases in surface water consents that would permit more vessels to operate in the Dusky Sound complex or for vessels with existing concession agreements to operate for extended hours.

Objective 47: Assess and monitor populations of fur seals in the Dusky Sound complex and report on the initial results of the assessment by 2017.

***Explanation*:** New Zealand fur seals are high trophic level predators that usually forage offshore, exploiting the deep scattering layer close to the shelf edge. High trophic level predators such as fur seals are food web integrators and so are key indicators of the health of the food web that they exploit. Changes in their feeding or demography are often indicative of changes in the structure or health of the whole food web. In this way, fur seals can be considers sentinels of changes in ocean health. Fur seals are also vectors for the flow of nutrients from offshore to inshore systems. Their scats contain nutrients that they have harvested deep offshore, which they deliver to their rookeries in coastal zone. Such vector species have great potential to enhance coastal productivity through the delivery of key nutrients and trace nutrients such as nitrogen, iron and zinc. The proximity of the shelf edge to the Dusky Sound complex means that this region has potential as a particularly useful habitat for fur seals. However, little is known about how fur seals use the Fiordland Marine Area or how their populations are changing over time. This information is important in order to recognise changes in ocean health over time and to critically appraise the effectiveness of spatial management in enhancing the link between marine and terrestrial systems in the Dusky Sound complex.

***Action 1*:** Locate and map seal rockeries (breeding areas) in the Dusky Sound complex by 2015.

***Action 2*:** Undertake baseline monitoring of fur seal populations at key sites identified in Action 1 using mark-recapture of pups. The first survey should take place in 2016

***Action 3*:** Continue population monitoring at selected sites and review every 5 years.

***Action 4*:** Foster and support research on the ecological role of fur seals in the Dusky Sound complex by third parties.

7.1.2 Marine habitats

Objective 48: Increase the protection of fragile encrusting organisms from the effects of anchoring by 2018.

***Explanation*:** The Fiordland Marine Area is home to communities of diverse and rare fragile encrusting marine organism of great national and international significance. In particular the Dusky Sound complex is a site of outstanding and high diversity. These communities are slow growing and are at risk of physical damage from SCUBA divers but more greatly by damage caused by anchoring. Fragile encrusting organisms are not afforded direct protection through legislation of marine reserves as their main threat lies in physical damage and not extractive exploitation. These communities are protected within the FMA in 'China Shops' or non-anchoring zones. However the selection of China Shop locations was not comprehensive and their locations are not always tightly described. Very little about the true biodiversity or distribution of these communities is known and so the effectiveness of China Shop protection is unclear. Information regarding safe anchoring sites is available in the Fiordland user guide and several privately managed moorings exist in the region.

***Action 1*:** Starting in 2014, advocate that cruise ships be entirely prohibited from anchoring (except for emergency anchoring) in the Dusky Sound complex, including the area outside of the commercial exclusion zone boundary in the vicinity of Five Fingers Peninsula. If this action is not feasible (determined by end 2014), suitable anchorages should be determined and advocacy should be for cruise ship Deed of Agreements to include anchoring restrictions (by end 2015). Suitable anchorages could be suggested by vessel operators and vetted using side scan sonar and remotely operated vehicle surveys to check for fragile encrusting organisms.

***Action 2*:** Starting in 2014, advocate for Environment Southland to assess the feasibility of developing anchorage zoning for the Dusky Sound Complex. "Green anchoring" (areas of limited environmental impact) and "no-anchoring" (high environmental impact) zones can be determined using Fiordland GIS Habitat Classification Maps (Wing el al. 2004) and the feasibility of any Green Zones should be ground-truthed using ROV surveys (Action 3). Ideally the whole coastline should be zoned either green or red, and the zonation would be specified by legal guidelines.

***Action 3*:** Assess potential anchorages identified in Actions 1 and 2 using ROV survey during 2014-2018. If potential anchorages are deemed unsuitable due to high abundances, diversity or instances of rare encrusting organisms, alternative anchorages should be identified

Objective 49: Enlarge the conservation of marine biodiversity in the Dusky Sound complex and monitor responses in an adaptive management framework.

***Explanation*:** In 2005 the FMMA closed to fishing the waters of Moana Uta Marine Reserve and Taumoana Marine Reserve along with six other regions Fiordland wide, with the purpose of conserving the unique world heritage of rare species, high biodiversity and ecological processes contained within the region. This legislation was developed under an 'adaptive management paradigm' whereby monitoring of changes in the marine communities are used to inform managers of the effectiveness of the marine reserve network. The management measures can then be adapted or customised through time, to enhance the desired response. Monitoring of the Fiordland Marine Area since 2005 has shown that populations of commercially important species (rock lobster and blue cod) are increasing in response to protection and that marine reserves in mid-outer fiord habitats and especially reserves that are surrounded by larger commercial exclusion zones are the most valuable in generating increases in densities and larger animals (Jack & Wing *in press*). This highlights the disproportional potential per unit area of marine reserves situated in outer coast habitat to generate a build up of high densities of large breeding stock. Also highlighted is the value of commercial exclusions zones which work as a buffer, enhancing the action of spatial closures in marine reserves. Whole communities of non-target and exploited fish species are now more stable in Fiordland's marine reserves than in other management regions but in open fished areas and commercial exclusion zones, these communities continue to become further degraded (Wing & Jack In press). Taumoana (Five Fingers Peninsula) Marine Reserve is uniquely valuable in that it contains some of the most productive and diverse protected habitats in the FMA. Terrestrial conservation plans for the peninsula region, which contains potentially valuable habitat for nesting seabirds and seal rookeries, also make this reserve a prime location for a world-class example of holistic management 'across ecotone boundaries'.

***Action 1*:** Starting in 2013, consult with the Fiordland Marine Guardians and associated agencies to investigate the potential of increasing the extent of the Taumoana (Fiver Fingers Peninsula) Marine Reserve to encompass representative outer coast habitat and the associated land/coast interfaces.

***Action 2*:** Consult with the Fiordland Marine Guardians and associated agencies to investigate the potential for the development of a commercial exclusion zone around Taumoana (Five Fingers Peninsula) Marine Reserve.

***Action 3*:** Continue monitoring of marine communities in the Dusky Breaksea Complex, in keeping with marine monitoring of the whole FMA (2015, every five years). The scale of resolution of this monitoring programme supports assessment of the whole of the FMA, across all marine reserves at a regional scale.

***Action 4*:** In keeping with work started by Willis *et al.* (2009), develop a baseline for the monitoring of marine communities in the Dusky Breaksea Complex to accurately assess changes in each management unit over time (CEZ, Taumoana Marine Reserve, Moana Uta Marine Reserve, open regions). A minimum of 6 survey sites is recommended for each reserve. The survey design must be carefully stratified to

incorporate variability along environmental gradients and seasonal changes in abundance of fish and mobile invertebrates including rock lobster. Effort should be made to estimate size frequency of key harvested species. Surveys are recommended every three years.

7.1.3 Marine invasive species

Objective 50: Eliminate *Undaria pinnatifida* from the Dusky Sound complex by January 2015.

***Explanation*:** Since *Undaria pinnatifida* was present in Sunday Cove, Breaksea Sound in 2010 , the Undaria Response Team (Department of Conservation, Environment Southland, MPI) have controlled the incursion to the point that eradication seems likely in the next few years. The dispersal phase of undaria, the gametophyte, can however remain viable for two and a half years.

***Action 1*:** In continuation of the current joint agency response programme, the undaria Response Team will conduct monthly inspections of Sunday Cove and the surrounding area and remove/destroy all undaria specimens (2013-January 2015). The programme should continue in accordance with the MOU set out between MPI, Department of Conservation and Environment Southland.

***Action 2*:** The Undaria Response Team will conduct regular inspections of the Sunday Cove area and any other known previous hotspots of undaria incursion after monthly surveys conclude (2015-2017)

***Action 3*:** Department of Conservation will conduct biosecurity checks for invasive marine organisms including undaria in the Sunday Cove region and any other known pervious hot spots frequently (2017-onwards).

Objective 51: Prevent the invasion of new marine invasive organisms in the Dusky Sound complex.

***Explanation*:** Invasive marine organisms pose a great threat to the Fiordland Marine Area as a whole. Preventing incursions is critical because their removal after invasion is expensive and often impossible. Whilst it is a legal offense to translocate pest organisms for example in ballast or on fouled hulls, there is not yet a legal framework to ensure compliance in the Fiordland Marine Area. Prevention of incursion of invasive marine organisms in the Dusky Sound complex should be undertaken as part of a larger programme in collaboration with MPI, Environment Southland and the Fiordland Marine Guardians in the greater FMA.

***Action 1*:** Use the survey of recreational vessels to better identify users of the Fiordland Marine Area. Provide users with clear information regarding their legal requirement for a clean hull and with information about how clean hull requirements can be met from 2015

***Action 2*:** Support the development of a Marine Pest Pathways Plan for Fiordland (led by Environment Southland) during 2013-2014.

7.2 Goal 4: Human values and use

7.2.1 Public and stakeholder participation

Objective 52: A two-way transfer of information between Department of Conservation and interested parties (those potentially affected by the Dusky Sound restoration and management project), is achieved through the completion of a joint Department of Conservation/Public Communication Plan by 1 July 2014.

***Explanation*:** Involving the public and stakeholders in all aspects of the Dusky Sound project, including decision-making processes makes good sense; "locals" have a good knowledge of the local environment and what will and will not work in terms of their well-being and the environment. Public involvement may also assist in reducing or avoiding controversy and objections from interested parties and assist in developing wider support for the eventual decisions. A communication plan also provides an opportunity for all persons to present their views thus providing useful additional information to aid in decisions, and ensures a democratic process with clear accountability.

***Action 1*:** Engage a suitably qualified person to draft a joint communication plan by 1 September 2013. Suggested methods to implement the communication plan include a community liaison group, a web-based discussion board and other methods that seek active involvement.

7.2.2 Visitor use and impacts

Objective 53: Improve understanding of effects of visitor use on terrestrial and freshwater ecosystems by undertaking surveys of visitor use within the project area by 2016.

***Explanation*:** The effects of visitor use on terrestrial and freshwater biodiversity values are not well-understood at present. Visitors could have potentially major effects, especially with respect to the introduction of pest plants such as didymo, and pest animals such as rodents to pest-free islands. Key visitor groups are concessionaires that visit terrestrial sites, recreational boat traffic that lands on islands, and to a lesser extent, tramping parties that visit the project area from the Dusky Track. Sites with high visitor use should be inspected to ensure that visitor use is not compromising biodiversity values.

***Action 1*:** Undertake surveys of visitor use during 2013-2015.

***Action 2*:** Write a report documenting the results of the visitor use surveys by 2016.

***Action 3*:** Assess visitor impacts at high use sites and take any necessary actions to prevent visitor impacts from compromising indigenous biodiversity values.

7.2.1 Historic and cultural heritage

Objective 54: Ensure that historic and cultural heritage values are protected when planning biodiversity projects within the project area, on an ongoing basis.

***Explanation*:** Generally heritage values and management are not incompatible with biodiversity management objectives. However, to ensure that no work or decisions lead to the inadvertent damage of archaeological sites or other heritage values, ALL personnel (staff, volunteers, and contractors) working at a site must be made aware of accidental discovery protocols (Appendix 5). Staff should be urged to avoid undertaking any unplanned responsive work that involves ground disturbance. Awareness of the protocol can also assist in the identification of archaeological sites that are not yet recorded. Staff working on biodiversity projects often traverse areas of land that have not been visited for a very long period of time, and they have an increased chance of accidental discoveries in these circumstances. All reports are welcomed.

One of the objectives of the Department's Statement of Intent is that "History is protected and brought to life". This has important implications for actively conserved places[1], where the focus of work includes bringing the story and values of the place to life. For any work or decisions that could affect the opportunity of New Zealanders and other visitors to visit and experience the actively conserved historic places identified above, advice should be sought from the Historic and Cultural Heritage advice team in Shared Services.

To protect heritage values, in planning ALL future work the following steps should be followed for any activities and decisions that may involve or lead to ground disturbance or impact (including repeated foot traffic). This includes new track and trap networks, and new huts. The number of steps required will depend on the presence/absence of sites, their nature, and the nature of the proposed work.

***Action 1*:** Check Department of Conservation GIS archaeological sites layer to determine if there are recorded archaeological sites as an initial check. Remember that there may be unrecorded sites, and heritage specialists can advise on the likelihood of this.

***Action 2*:** Contact the Historic and Cultural Heritage advice team in Shared Services to ask advice on what potential impact the proposal may have on recorded or potential unrecorded archaeological sites, and how to include heritage values in project planning and budgeting.

***Action 3*:** In discussion with the assigned technical adviser from the Historic and Cultural Heritage advice team determine if any archaeological sites and values that are present can be avoided by modification of the proposal and, where they can't be avoided, what alternatives there are for minimising impacts.

[1] Within the project area, actively conserved places are: Astronomer Point, Pickersgill Harbour; Endeavour wreck, Facile Harbour; Indian Island contact site; Luncheon Cove sealing and ship building base, Anchor Island; Richard Henry's house site, Pigeon Island.

***Action 4*:** Where a site or sites have cultural values for Tangata Whenua then the proposal must be taken to Kaitiaki Roopu and/or discussed with the relevant Kaitiaki Runaka by the project planner. Tangata Whenua may request a cultural values assessment and impact assessment.

***Action 5*:** Where a site (or sites) cannot be avoided and is, or has the potential to be, pre-1900 the NZ Historic Places Trust should be contacted with regard to Archaeological Authority requirements under the Historic Places Act. The technical adviser from the Historic and Cultural Heritage advice team can help with this and assist with the authority application.

***Action 6*:** For an Archaeological Authority, or for work that has major impacts on any post 1900 sites, an archaeological assessment will be required, including an assessment of affects. This must be undertaken by a suitably qualified archaeologist. Planning for the project must include a budget for this work which is likely to be contracted. The technical adviser from the Historic and Cultural Heritage advice team can help with identifying a contractor and drafting a contract.

7.3 Summary of restoration objectives for Dusky Sound

The restoration objectives listed above are associated with relative priorities and performance indicators in Table 13. The performance indicator for successful translocations is taken from Miskelly and Powlesland (2013).

Table 13: Summary of restoration objectives and actions and their priorities and timeframes for the Dusky Sound project area.

Objectives and Actions	Priority	Performance Indicators
Pest and Weed Control Objectives (Goal 1)		
Objective 1: Maintain or improve the pest status of all islands that are pest-free or have a limited suite of pests, on an ongoing basis	**High**	Islands that are currently pest-free remain pest free. Islands with limited pest assemblages have the same or fewer pest species present.
Objective 2: Complete the Resolution Island stoat eradication operation by 2020, or if eradication is not feasible, control stoats to low density on an ongoing basis.	**High**	Scenario 1: Resolution Island is free of stoats Scenario 2: Specified low density thresholds for stoats are not exceeded Both scenarios: The response of mice to zero or reduced stoat densities is understood.
Objective 3: Complete the Resolution Island deer eradication operation by 2020, or if eradication is not feasible, control deer to low density on an ongoing basis.	**High**	Scenario 1: Resolution Island is free of red deer by 2020. Scenario 2: Specified low density thresholds for deer are not exceeded
Objective 4: Undertake stoat control in the buffer zones of all islands where stoats have been eradicated or are being maintained at zero density, to reduce reinvasion risk.	**High**	Stoats are controlled to below specified densities in buffer areas, and this has resulted in significantly lower reinvasion rates

Objectives and Actions	Priority	Performance Indicators
Objective 5. Investigate the feasibility of eradicating pest species from islands where the benefits of eradication outweigh those of control or status quo management, by 2016.	Medium	The feasibility of eradicating pest animals from Resolution, Entry, Parrot, Pigeon, Long, and Cooper Islands has been critically assessed by 2016
Objective 6: Ensure all pest control operations that take place in the Dusky Sound area are assessed against current information regarding potential non-target effects on long-tailed and short-tailed bats	**High**	An assessment of non-target effects on bats is completed whenever toxins are proposed for pest control in the Dusky Sound area.
Objective 7: Establish short-term and long-term monitoring of vegetation condition, using existing baseline data were possible	**High**	At least 50 long-term vegetation monitoring plots have been established in appropriate sites by 2014
Objective 8: Control gorse within the project area on an ongoing basis, and develop and implement weed biosecurity and surveillance protocols by July 2014	**High**	Annual reports on weed control and surveillance operations are available. A weed biosecurity plant has been prepared by July 2014.
Translocation Objectives (Goal 2)		
Vegetation/habitat Mapping Objectives		
Objective 9: Develop a management-informative mappable vegetation/habitat classification for the project area by July 2014	**High**	A mappable vegetation/habitat classification for the project area has been developed by July 2014.
Objective 10: Use the classification to progressively map vegetation and habitats on islands greater than 4 ha in size (and other areas if required by other objectives) within the project area by 2020	Medium	Vegetation/habitat maps are available for Resolution Island, and Anchor Island are available by 2015, and for Long Island and Cooper Island by 2016. All islands greater than 4 ha in size have been mapped by 2020.
Avifauna Objectives		
Objective 11: Undertake an inventory of seabird breeding locations on islands within the Dusky Sound project area by July 2015.	**High**	A database is established by September 2013 to record seabird observations. A process for reporting seabird observations is established and working by 2014. Five Fingers Peninsula and at least three islands have been surveyed for seabird populations in 2014.
Objective 12: Evaluate islands within the Dusky Sound project area to undertake acoustic attraction and/or translocation of burrowing seabird populations by 2018.	Medium	A full evaluation of the potential of islands for seabird attraction or translocation has been undertaken by 2018
Objective 13: Continue to assess long-term population trends of Fiordland crested penguin within the Dusky Sound project area on an ongoing basis	**High**	Breaksea Island colony sites are monitored as per protocol. A full survey of Breaksea Island is undertaken by 2014. A repeat distribution survey of Dusky Sound is undertaken by 2015.
Objective 14: Establish a long-term outcome monitoring programme for key forest birds on Resolution Island in 2013	Medium	Monitoring protocol is established in consultation with trapping personnel, and data is of good quality and being stored in a spreadsheet.

Objectives and Actions	Priority	Performance Indicators
Objective 15: Undertake further translocations of mohua to Dusky Sound islands with low stoat populations if Resolution Island mohua population is shown to be secure	Medium	Populations established on at least one island, and expected to persist for at least 50 years under the current site management regime.
Objective 16: Assess the presence of southern Fiordland tokoeka on Cooper Island by 2015, and undertake translocations by 2018 if presumed to be absent.	Medium	A southern Fiordland tokoeka population is established on Cooper Island
Objective 17: Undertake translocations of little spotted kiwi to Anchor Island by 2018	**High**	Population established on Anchor Island and expected to persist for at least 50 years under the current site management regime.
Objective 18: Evaluate Resolution, Cooper, and Long Islands for the translocation of little spotted kiwi by 2018	Medium	An evaluation of the feasibility of little spotted kiwi transfer to Resolution, Cooper, and Long Islands is available by 2018.
Objective 19: Undertake translocations of brown teal (North Island) to Resolution Island by 2018	**High**	Population established and expected to persist for at least 50 years under the current site management regime.
Objective 20: Assess habitat suitability and availability for brown teal (North Island) on Anchor, Long, and Cooper Islands by 2018	Medium	Habitat assessments of these islands is undertaken, and translocation proposals completed if suitable.
Objective 21: Assess changes in quality and suitability of potential takahe habitat on Resolution Island at five-year intervals from 2014.	**High**	Alpine vegetation is monitored at five-year intervals on Resolution Island. Vegetation surveys are undertaken on Five Fingers Peninsula.
Objective 22: Determine the distribution of tui on islands within the Dusky Sound project area and assess the need for reintroductions by 2018	**High**	The current distribution of tui in the Dusky Sound project area has been mapped. An evaluation of the need for tui reintroduction is available in 2018.
Objective 23: Determine the presence of weka on Long and Cooper Islands, and the adjacent mainland, by 2018	**High**	The status of western weka in the Dusky Sound project area is known by 2018
Objective 24: Undertake translocations of Snares Island snipe to Anchor Island by 2018.	**High**	Population established and expected to persist for at least 50 years under the current site management regime
Objective 25: Confirm the outcomes of the Secretary and Resolution Island South Island robin translocation and self-introductions by 2018, and evaluate the need for further robin translocations to other islands by 2019.	**High**	Annual surveys are completed on Resolution Island and Secretary Island. A further translocation is undertaken on Resolution Island in the event that the island population is shown to be increasing. A report evaluating the need for further robin translocations is available by 2019
Objective 26: Evaluate the suitability of Resolution Island for South Island saddleback translocations by 2018, and undertake a translocation if appropriate.	**High**	Stoat capture data, and the success of mohua and robin translocations are used to assess the suitability of Resolution Island. A translocation is undertaken if appropriate.
Objective 27: Confirm the outcome of the Secretary Island kokako translocation through a further survey in 2014.	**High**	Complete a further survey for kokako on Secretary Island in 2013-2014

Objectives and Actions	Priority	Performance Indicators
Objective 28: Reassess the possibility of translocations of rock wren to the Dusky Sound project area by 2018 and undertake a translocation if appropriate by 2023	Medium	Species experts are consulted. Translocation is undertaken if appropriate.
Objective 29: Reassess the possibility of translocations of shore plover, southern New Zealand dotterel, kakapo, and blue duck in 2023.	Low	Species experts/recovery groups are contacted in 2023 to evaluate the suitability of islands for translocations.
Objective 30: Reassess the possibility of translocations of southern New Zealand dotterel to the Dusky Sound project area in 2023	Low	A report assessing habitat suitability on Resolution Island for southern New Zealand dotterel is available in 2020. A reassessment of translocation potential for this species is undertaken in 2023.
Objective 31: Reassess the potential for further translocations of kakapo to the Dusky Sound project area in 2023	Low	A report reassessing the potential for further reintroductions of kakapo to pest-free islands in the project area is available by 2024.
Objective 32: Reassess the potential for translocations of blue duck to the Dusky Sound project area in 2018	Medium	A report assessing the potential for reintroduction of blue duck to the project area is available in 2019.
Objective 33: Reassess the potential for translocations of orange-fronted parakeet to the Dusky Sound project area in 2023	Low	A report assessing the potential for reintroduction of orange-fronted parakeet to the project area is available in 2024.
Herpetofauna Objectives		
Objective 34: Conduct an opportunistic lizard inventory of the Dusky Sound project area from July 2013, which incorporates casual observations by staff conducting management work and the public into a formal record keeping system with follow-up searches.	**High**	A database has been set-up and running, with clear data and communication pathways by 2014. Staff and public are enabled to collect casual data through advocacy material and workshops. Database continues to be populated regularly and data are beginning to indicate population increases in some parts of the project area.
Objective 35: Assess potential tuatara habitat on islands within the Dusky Sound project area by 2020.	Medium	A report assessing potential tuatara habitat, including soil temperature and moisture conditions for incubation of tuatara eggs, is available in 2020.
Objective 36: Implement translocations and reintroductions of suitable herpetofauna species to pest-free (including mice) islands ≥ 20-years post-pest eradication.	Medium	From 2033, translocations and reintroductions have restored lost and appropriate herpetofauna elements to the Dusky Sound project area.
Objective 35: Undertake targeted herpetofauna surveys on islands where restoration activities, such as weka reintroductions, can result in a significant adverse effect on resident herpetofauna.	Low	Intermittent, targeted herpetofauna searches have been carried out since 2013 in response to restoration actions which had the potential to adversely impact on herpetofauna. Information from surveys was provided to decision makers prior to the restoration action of concern being implemented.

Objectives and Actions	Priority	Performance Indicators
Bat Objectives		
Objective 36: Determine the presence of bat populations within the Dusky Sound project area by 2017	**High**	A report on the status of bat populations in the Dusky Sound project area is available in 2017.
Objective 37: Consider translocation of short-tailed bat and long-tailed bat to suitable habitats if bats remain undiscovered within the Dusky Sound project area past summer 2017-2018.	Medium	If bats are not present, a report assessing the feasibility of bat translocations to the Dusky Sound project area is available in 2019.
Freshwater Habitat Objectives		
Objective 38: Complete a targeted survey of freshwater fauna within the Dusky Sound project area by 2018.	Medium	A survey report updating the status of freshwater biota in poorly-surveyed parts of the Dusky Sound project area is available in 2019.
Objective 39: Prevent introduction of aquatic pest plants such as didymo	**High**	Didymo and other aquatic pest plants are not present in the Dusky Sound project area
Terrestrial Invertebrate Objectives		
Objective 40: Obtain quantitative information on the distribution and abundance of indigenous beetle and moth fauna within the Dusky Sound project area by 2015.	**High**	A report on the baseline invertebrate survey is available in 2015. A report comparing the results of the baseline survey and a repeat survey is available in 2020.
Objective 41: Assess the response of indigenous invertebrate communities to different pest assemblages within the Dusky Sound project area by 2016	**High**	A report on the response of invertebrate communities to different pest assemblages in the Dusky Sound project area is available in 2016.
Objective 42: Assess the status of *Hadramphus stilbocarpae* and *Anagotus fairburni* on Breaksea Island by 2015	**High**	A report on the status of the two beetles on Breaksea Island is available in 2015.
Objective 43: Improve understanding of the distribution and abundance of *"Powelliphanta" fiordlandica* on Resolution Island.	**High**	A report on the distribution and abundance of *"Powelliphanta" fiordlandica* in the Dusky Sound project area is available in 2016.
Marine Objectives (Goal 3)		
Objective 44: Improve conservation measures for bottlenose dolphins in the Dusky Sound complex by 2017.	Medium	Department of Conservation advocacy has resulted in better protection of the bottlenose dolphin population and its threat status has decreased.
Objective 45: Assess the use of the Dusky Sound complex by recreational and commercial vessels and report on findings by 2017	Low	Survey methodology has been developed, surveys have been undertaken, and a report detailing findings is available in 2017.
Objective 46: Advocate for a high level of caution when assessing future commercial concessions for tourist vessels in the Dusky Sound complex.	**High**	No new consents for surface water activities in Dusky Sound complex have been issued without a rigorous assessment of potential adverse effects on indigenous marine biodiversity.
Objective 47: Assess and monitor populations of fur seals in the Dusky Sound complex and report on the initial results of the assessment by 2017.	Low	An initial report on the distribution and abundance of fur seals in the Dusky Sound complex is available in 2017.

Objectives and Actions	Priority	Performance Indicators
Objective 48: Increase the protection of fragile encrusting organisms from the effects of anchoring by 2018	Medium	Appropriate anchorage locations have been identified and are being used, and inappropriate anchorages have been identified and are not being used for anchoring, from 2018 onwards.
Objective 49: Enlarge the conservation of marine biodiversity in the Dusky Sound complex and monitor responses in an adaptive management framework.	Medium	The extent of marine protected areas in the Dusky Sound complex has increased over 2012 levels, and the benefits of this are understood and supported by stakeholders.
Objective 50: Eliminate Undaria pinnatifida from the Dusky Sound complex by January 2015.	**High**	No undaria plants are recorded in the Dusky Sound project area after 2015.
Objective 51: Prevent the invasion of new marine invasive organisms in the Dusky Sound complex	**High**	No new marine invasive organisms are established in the Dusky Sound complex.
Human Use Objectives (Goal 4)		
Objective 52: A two-way transfer of information between DOC and interested parties (those potentially affected by the Dusky Sound restoration and management project), is achieved through the completion of a joint DOC/Public Communication Plan by July 1st 2015.	**High**	A consultative decision-making style from 2013 has resulted in a high degree of public buy- in to even controversial restoration activities. Sponsors contribute significantly to the costs of essential management operations over the Dusky Sound Project Area.
Objective 53: Improve understanding of effects of visitor use on terrestrial and freshwater ecosystems by undertaking surveys of visitor use within the project area by 2016.	Low	A report describing patterns of visitor use is available in 2016. Visitor use is not compromising indigenous biodiversity values.
Objective 54: Ensure that historic and cultural heritage values are protected when planning biodiversity projects within the project area, on an ongoing basis.	**High**	Historic and cultural heritage sites suffer no damage from biodiversity projects. New discoveries of historic and cultural heritage sites have been made by biodiversity workers, and reported correctly through accidental discovery protocols.

8. PRIORITY ACTIONS AND SITES

Islands which currently have no pest animals are a high priority for biosecurity actions to prevent their colonisation, or to swiftly detect and remove any new pest incursions. Anchor Island, Indian Island, and their associated pest-free islands are important in this respect. Anchor Island is likely to remain pest-free and, as such, provides valuable habitat for more vulnerable bird species such as little spotted kiwi. It already supports translocated populations of kakapo, mohua, South Island robin and saddleback, and further recommended translocations that could potentially be undertaken within the next 10 years include little spotted kiwi, Snares Island snipe, brown teal, and rock wren.

Resolution Island stands out as a site where rats and possums are absent and where deer and stoats can be controlled to low levels. If deer and stoats cannot be eradicated or maintained at zero density, Resolution Island remains a high priority for ongoing

control of these pests, which is more cost-effective than similar control undertaken on mainland sites. The Five Fingers Peninsula stands out as an important site within Resolution Island, for invertebrates, lizards, coastal vegetation, forest bird habitat, and restoration of terrestrial-marine interactions. The peninsula is also likely to provide extensive, suitable burrowing seabird habitat, and may still support remnant populations. Subject to the results of seabird surveys and habitat surveys on the peninsula, it could provide a location for the translocation and/or acoustic attraction of burrowing seabird species. If long-term monitoring indicates that the peninsula can be kept essentially free of stoats, it will offer a large, secure area for bird species that are vulnerable to stoat predation. Translocations of brown teal and South Island saddleback may be best released into this area. Long-term possibilities for introduction such as North Island kokako, kakapo, and takahe would ideally also be released on the peninsula.

Control of stoats and rodents to low densities on Long Island and Cooper Island would make these islands available for mohua, robin, possibly saddleback, and possibly rock wren and brown teal, in addition to protecting the resident southern Fiordland tokoeka populations. Depending on the success of long-term management of pests on the islands, other more susceptible bird species could potentially be introduced in the longer term.

A number of other islands are associated with conservation and restoration priorities. Table 14 summarises conservation and restoration actions, and their relative priorities, for all islands larger than 4 ha within the Dusky Sound project area, and the adjacent mainland.

9. CONCLUSION

The Dusky Sound project area is one of the least modified parts of mainland New Zealand and its inshore islands and, as such, warrants the conservation and restoration actions proposed in this report. Resolution Island is the fifth largest island in New Zealand, and offers a strategic opportunity to protect a very large area of diverse indigenous habitat - from sea level to the alpine zone - in which populations of a large range of pest-susceptible indigenous fauna could thrive if pests could be held at zero or very low densities. This opportunity would be made more feasible if pest control in buffer areas on the adjacent mainland and on stepping-stone islands was effective at reducing pest reinvasion. Adjacent islands are also strategically important as areas which are entirely free of pest animals or where pests such as possums and hedgehogs are absent, and where the likelihood of pest reinvasion is reduced. If pests can be eliminated from this island assemblage, reinvasion from the adjacent mainland slowed, and any reinvading pests swiftly detected and controlled - potentially possible with self-resetting traps - then the biodiversity outcomes originally envisaged by Richard Henry could be realised and surpassed. The difficulties in achieving these outcomes will be considerable, but significant progress has been made, and as knowledge grows, these difficulties are likely to reduce. Undertaking the actions suggested in this report would considerably advance progress toward the major biodiversity achievement that is possible within the Dusky Sound project area.

Table 14: Main biodiversity actions and associated priorities for islands (over 4 ha) and adjacent mainland sites within the Dusky Sound project area. Management status is based on Department of Conservation (2007). Current pest assemblages are not fully known for some islands.

Site for Conservation/ Restoration	Area (ha)	Management Status	Current Known Pest Status	Conservation and Restoration Actions	Explanation
Resolution Island	20,887	Restoration	Stoat, deer control, mice present	**High Priority** • Continue stoat and deer control to low levels. • Evaluate Five Fingers Peninsula for seabird restoration. • Undertake further translocation of mohua. • Undertake translocation of brown teal. • Confirm status of mohua. • Confirm status of South Island robin. • Undertake further translocation of South Island robin if population is stable or increasing. • Assess suitability for North Island kokako if Secretary Island population has failed and reason is known. • Undertake a comprehensive invertebrate survey covering seasonal and altitudinal variation and nocturnal and diurnal species, noting invertebrate-plant relationships. • Assess whether bats are present. **Medium Priority** • Investigate feasibility of mouse eradication. • Monitor key forest birds. • Undertake subalpine vegetation monitoring to determine suitability for takahe. • Undertake vegetation monitoring on Five Fingers Peninsula to determine suitability for takahe. • Investigate feasibility of blue duck translocations if mainland pests are controlled. • Investigate feasibility of little spotted kiwi translocations • Investigate feasibility of South Island saddleback translocations. • Undertake a comprehensive invertebrate survey in different seasons at range of altitudes; including nocturnal and diurnal species, and noting invertebrate-plant relationships. • Consider suitable herpetofauna translocations ≥20 years post pest eradication.	Resolution Island is the highest priority for conservation and restoration action in the project area due to its size and habitat diversity. Five Fingers Peninsula may provide the best opportunity for maintaining very low stoat and deer numbers, and should be the focus for many of the management actions. It is important to document the indigenous invertebrate assemblage on Resolution Island both as a baseline survey, and because information on the structure and composition of the invertebrate assemblage will drive management of important invertebrate populations and assist management of indigenous fauna that feed on invertebrates.

Site for Conservation/ Restoration	Area (ha)	Management Status	Current Known Pest Status	Conservation and Restoration Actions	Explanation
				Low Priority • Undertake assessment of habitat availability for shore plover. • Undertake assessment of habitat availability for southern New Zealand dotterel.	
Adjacent mainland	Extensive	Not applicable	Occasional possum control, full suite of pests present	**High Priority** • Periodic aerial 1080 (every three years or mast-timed). **Low Priority** • Undertake weka call count surveys to assess status of population to clarify the importance for protection on secure islands.	The Fiordland mainland is a high priority as controlling predators here provides a powerful buffer for islands within the project area, particularly the largest islands; Resolution, Cooper and Long. It also provides extensive habitat for fauna dispersing from island refuges.
Anchor Island	1,137	Restoration	Pest free	**Medium Priority** • Undertake translocation of little spotted kiwi. • Undertake translocation of Snares Island snipe. • Investigate feasibility of brown teal translocations.	Anchor Island is a highly valuable, pest-free site which already receives significant fauna management. It has the potential to provide long term restoration of a range of threatened fauna in addition to birds.
Breaksea Islands	156	Refuge	Pest free	**High Priority** • Assess the current population status of the translocated flax weevil and knobbed weevil populations on Breaksea Island.	Though Breaksea is a refuge, it has been affected by rodents, and it is likely to have lost components of its flora and fauna. Its relatively secure pest-free status provides the potential for protection of a range of threatened fauna in addition to birds. The fate of the translocated flax weevil and knobbed weevil populations is not known and should be assessed.
Indian Island	168	Open Sanctuary	Occasional stoat captures	**High Priority** • Undertake translocation of mohua. • Confirm status of South Island robin.	Small island previously affected by rodents and stoats.
Long Island (including East Point Island)	1,899 (+45)	Open Sanctuary	Stoat control	**High Priority** • Investigate feasibility of pest control (rodents, deer). • Control stoats to zero or low densities. • Undertake weka call count surveys to assess status of population. • Assess whether bats are present.	Long Island has the potential to provide extensive habitat for a variety of flora and fauna, but will remain vulnerable to reinvasion of pests. It is likely to be less vulnerable than Cooper Island. Establishment of a

Site for Conservation/ Restoration	Area (ha)	Management Status	Current Known Pest Status	Conservation and Restoration Actions	Explanation
				Medium Priority • Investigate feasibility of mohua translocations. • Investigate feasibility of little spotted kiwi translocations. • Investigate feasibility of brown teal translocations. • Investigate feasibility of South Island robin translocations.	mainland buffer may provide significant protection from reinvasion for this site.
Cooper Island	1,779	Open Sanctuary	Possum free	**High Priority** • Investigate feasibility of pest control (rodents, deer). • Control stoats to zero or low densities. • Survey for southern Fiordland tokoeka. • Undertake weka call count surveys to assess status of population. • Assess whether bats are present. **Medium Priority** • Investigate feasibility of mohua translocations. • Investigate feasibility of little spotted kiwi translocations. • Investigate feasibility of brown teal translocations. • Investigate feasibility of South Island robin translocations. • Undertake translocation of southern Fiordland tokoeka (dependent on presence).	Cooper Island has the potential to provide extensive habitat for a variety of flora and fauna, but will remain vulnerable to reinvasion of pests, and more so than Long Island. Establishment of a mainland buffer may provide significant protection from reinvasion for this site.
Entry Island	38	Refuge	Mice	**High Priority** • Investigate feasibility of mouse eradication. • Investigate suitable herpetofauna translocation ≥20 years post pest eradication.	
Many Islands	32	Restoration	Pest free	**High Priority** • Survey and evaluate for seabird restoration.	The small islands around Anchor Island are now all pest-free, though some like Nomans, Passage, Stop and Prove may have never supported pests. The pest status of this latter group should be assessed, and if confirmed, no restoration should be undertaken. The others provide excellent opportunities for restoration, particularly of seabirds.
Nomans Island	20	Restoration	Pest free		
Passage Islands	18	Restoration	Pest free		
Petrel Islands	28	Open Sanctuary	Pest free		
Prove Island	8	Restoration	Pest free		
Stop Island	10	Restoration	Pest free		
Seal Islands	29	Restoration	Pest free		
Parrot Island	40	Open Sanctuary	Occasional stoat captures, mice present	**Medium Priority** • Investigate feasibility of mouse eradication (in association with Resolution Island). • Investigate suitable herpetofauna translocation ≥20	

Site for Conservation/ Restoration	Area (ha)	Management Status	Current Known Pest Status	Conservation and Restoration Actions	Explanation
				years post pest eradication.	
Pigeon Island	73	Open Sanctuary	Occasional stoat captures, mice present	**Medium Priority** • Investigate feasibility of mouse eradication (in association with Resolution Island). • Investigate suitable herpetofauna translocation ≥20 years post pest eradication.	Pigeon Island is sufficiently close to Resolution Island that most mobile fauna is likely to colonise the island from Resolution Island.
Outer Gilbert Islands	11	Refuge	Pest free	**Medium Priority** • Assess the status of the knobbled weevil population.	The outer Gilbert Islands were the source of the translocation of knobbed weevil to Breaksea Island.
Inner Gilbert Islands	56	Open Sanctuary	Possum free		Combine with pest control on Resolution.
Crayfish Island	9	Open Sanctuary	Possum free		Combine with mainland pest control.
Girlies Island	17	Open Sanctuary	Possum free		Combine with mainland pest control.
Harbour Islands	48	Open Sanctuary	Possum free		Combine with mainland pest control.
Heron Island	6	Open Sanctuary	Possum free		Combine with mainland pest control.
John Islands	58	Open Sanctuary	Possum free		Combine with mainland pest control.
Oke Island	35	Open Sanctuary	Possum free		Combine with mainland pest control.
Curlew Island	12	Open Sanctuary	Possum free		Combine with pest control on Long Island.

ACKNOWLEDGMENTS

We are greatly appreciative of Department of Conservation support for this project. Leigh Marshall (Department of Conservation Te Anau) provided project liaison and coordinated a substantial flow of information from Department of Conservation sources that was critical to the compilation of this report and its completion within timeframe. We also thank those who participated in a meeting to discuss the project, those who provided constructive comment on drafts of the report, and those staff from various Department of Conservation offices throughout New Zealand who contributed helpful and timely advice when this was sought.

REFERENCES

Agnew D., Roberts A., and Harper G. 2008: Island Biosecurity Plan: Southland Conservancy. DOCDM-29722. New Zealand Department of Conservation Te Anau Area Office, Southland Conservancy

Allen R.B., Lee W.G., Johnson P.N., and Rance B.D. 1990: Breaksea Island: Vegetation and monitoring studies. DSIR Botany Division, Dunedin and Department of Conservation, Invercargill. 26 pp.

Allibone A.H., Milan L.A., Daczko N.R., and Turnbull I.M. 2009: Granulite facies thermal aureoles and metastable amphibolite facies assemblages adjacent to the Western Fiordland Orthogneiss in southwest Fiordland, New Zealand. *Journal of Metamorphic Geology 27*: 349-369.

Allibone A.H., Turnbull I.M., Tulloch A.J., and Cooper A.F. 2007: Plutonic rocks of the Median Batholith in southwest Fiordland, New Zealand: Field relations, geochemistry, and correlation. *New Zealand Journal of Geology and Geophysics 50*: 283-314.

Allibone R., David B., Hitchmough R., Jellyman D., Ling N., Ravenscoft P., and Waters J. 2010: Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research 44*: 271-287.

Angel A., Wanless R.M., and Cooper J. 2009: Review of impacts of the introduced house mouse on islands in the Southern Ocean: are mice equivalent to rats? *Biological Invasions 11*: 1743-1754.

Anonymous 2010: Incursion Response Plan Information for Fiordland Islands (Aug 2010). *Unpublished internal report*, Department of Conservation.

Arcangeli A. and Crosti R. 2009: The short-term impact of dolphin-watching on the behaviour of bottlenose dolphins (*Tursiops truncatus*) in Western Australia. *Journal of Marine Animals and Their Ecology 2*: 3-9.

Baker A.J., Miskelly C.M. and Haddrath O. 2010: Species limits and population differentiation in New Zealand snipes (Scolopacidae: *Coenocorypha*). *Conservation Genetics 11*: 1363-1374.

Baker S. 2010: Conservation status of New Zealand marine mammals (suborders Cetacea and Pinnipedia), 2009. *New Zealand Journal of Marine and Freshwater Research 44*: 101-115.

Barratt B.I.P. and Patrick B.H. 1987: Insects of snow tussock grassland on the east Otago plateau. *New Zealand Entomologist 10*: 69-98.

Beentjes M.P. and Carbines G.D. 2005: Population structure and relative abundance of blue cod (*Parapercis colias*) off Banks Peninsula and in Dusky Sound, New Zealand. *New Zealand Journal of Marine and Freshwater Research 39*:77-90.

Beer N.A. and Wing S.R. 2013: Trophic ecology drives spatial variability in growth among subpopulations of an exploited temperate reef fish. *New Zealand Journal of Marine and Fresh Water Research* 47: 73-89.

Beer N.A., Wing S.R., and Swearer S.E. 2011: Otolith elemental evidence for spatial structuring in a temperate reef fish population. *Marine Ecology Progress Series 44*: 217-227.

Besson A.A., Nelson N.J., Nottingham C.M., and Cree A. 2011: Is cool egg incubation temperature a limiting factor for the translocation of tuatara to southern New Zealand. *New Zealand Journal of Ecology 36*: 90-99.

Borkin K.M. and Parsons S. 2010: Plantation forests are used by the lesser short-tailed bat, *Mystacina tuberculata rhyacobia*. *New Zealand Journal of Zoology 37*: 13-17.

Bremner A.G., Butcher C.F., and Patterson G.B. 1984: The density of indigenous invertebrates on three islands in Breaksea Sound, Fiordland, in relation to the distribution of introduced mammals. *Journal of the Royal Society of New Zealand 14*: 379-386.

Buckley T.R., Palma R.L., Johns P.M., Gleeson D.M., Heath A.C.G., Hitchmough R.A., and Stringer I.A.N. 2012: The conservation status of small or less well known groups of New Zealand terrestrial invertebrates. *New Zealand Entomologist 35*: 137-143.

Buckstaff K.C. 2004: Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. *Marine Mammal Science 20*: 709-725.

Casas G., Scrosati R., and Piriz M.L. 2004: The invasive kelp *Undaria pinnatifida* (Phaeophyceae, Laminariales) reduces native seaweed diversity in Nuevo Gulf (Patagonia, Argintina). *Biological Invasions 6*: 411-416.

Colbourne R. 2005: Kiwi (*Apteryx* spp.) on offshore New Zealand islands. Populations, translocations and identification of potential release sites. *DOC Research and Development Series 208*. Department of Conservation, Wellington. 24 pp.

Constantine R., Brunton D.H., and Dennis T. 2004: Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behaviour. *Biological Conservation 117*: 229-307.

Coutts P.J.F. 1969: The Māori of Dusky Sound: A review of the historical sources. The *Journal of the Polynesian Society 78*: 178-211.

Coutts P.J.F. 1977: Archaeological studies in Dusky and Breaksea Sounds, south western Fiordland, New Zealand: a summary. *The Journal of the Polynesian Society 86*: 37-72.

Cowan P.E. 1990: Fruits, seeds, and flowers in the diet of brushtail possums, Trichosurus vulpecula, in a lowland podocarp/mixed hardwood forest, Orongorongo Valley, New Zealand. *New Zealand Journal of Zoology 17*: 549-566.

Cree A. and Butler D. 1993: Tuatara recovery plan. *Threatened Species Recovery Plan 9.* Department of Conservation, Wellington.

Croll D.A., Maron J.L., Estes J.A., Danner E.M., and Byrd G.V. 2005: Introduced predators transform subarctic islands from grassland to tundra. *Science 307*: 1959-1961.

Crouchley D., Nugent G., and Edge K.-A. 2011: Removal of red deer (*Cervus elaphus*) from Anchor and Secretary Islands, Fiordland, New Zealand. *In*: Veitch C.R., Clout M.N., and Towns D.R. (eds), Island invasives: eradication and management. pp. 422-425. IUCN, Gland, Switzerland.

Curiel D., Guidetti P., Bellemo G., Scattolin M., and Marzocchi M. 2002: The introduced alga *Undaria pinnatifida* (Laminariales, Alariaceae) in the Lagoon of Venice. *Hydrobiologia 477*: 209-219.

Currey R.J.C., Davson S.M., and E. Slooten E. 2009: Survival rates for a declining population of bottlenose dolphins in Doubtful Sound, New Zealand: an information theoretic approach to assessing the role of human impacts. *Aquatic Conservation*: *Marine and Freshwater Ecosystems 19*: 658-670.

Currey R.J.C., Dawson S.M., and Schneider K. 2010: Inferring causal factors for a declining population of bottlenose dolphins via temporal symmetry capture-recapture modeling. *Marine Mammal Science 27*: 554-566.

Currey R.J.C., Dawson S.M., and Slooten E. 2007: New abundance estimates suggest Doubtful Sound bottlenose dolphins are declining. *Pacific Conservation Biology 13*: 274.

Currey R.J.C., Rowe L.E., Dawson S.M., and Slooten E. 2008: Abundance and demography of bottlenose dolphins in Dusky Sound, New Zealand, inferred from dorsal fin photographs. *New Zealand Journal of Marine and Freshwater Research 42*: 439-449.

Davis J.P. and Wing S.R. 2012: Niche partitioning in the Fiordland wrasse guild. *Marine Ecology Progress Series 446*: 207-220.

de Lange P.J., Hitchmough R., Barkla J., Cameron E., Champion P., Courtney S., Heenan P., and Norton D.A. (in press): Conservation status of New Zealand vascular plants, 2012. New Zealand Threat Classification Series. Department of Conservation, Wellington.

de Paoli M.C., Clarke G.L., Klepeis K.A., Allibone A.H., and Turnbull I.M. 2009: The Eclogite-Granulite Transition: Mafic and Intermediate Assemblages at Breaksea Sound, New Zealand. *Journal of Petrology 50*: 2307-2343.

Dell R.K. 1955: The Land Mollusca of Fiordland, South-West Otago. *Transactions and Proceedings of the Royal Society of New Zealand 82*: 1135-1148.

Department of Conservation 2007: Fiordland National Park Management Plan. Southland Conservancy Conservation Management Planning Series. Department of Conservation, Invercargill. 366 pp.

Department of Conservation 2010: Fiordland Coastal Newsletter - March 2010. Department of Conservation, Invercargill. 4 pp.

Dowding J.E. 1999: Past distribution and decline of the New Zealand dotterel (*Charadrius obscurus*) in the South Island of New Zealand. *Notornis 46*: 167-180.

Dowding J.E. and Davis A.M. 2007: New Zealand dotterel (*Charadrius obscurus*) recovery plan, 2004-14. *Threatened Species Recovery Plan 58*. Department of Conservation, Wellington. 28 pp.

Dowding J.E. and Moore S.J. 2006: Habitat networks of indigenous shorebirds in New Zealand. *Science for Conservation 261*. Department of Conservation, Wellington. 99 pp.

Dowding J.E. and O'Connor S.M. 2013: Reducing the risk of extinction of a globally threatened shorebird: translocations of the shore plover (*Thinornis novaeseelandiae*), 1990-2012. *Notornis 60*: 70-84.

Duncan M. 2007: New Zealand-wide surveys in November 2006, February 2007 and May 2007 for the presence of the non-indigenous freshwater diatom *Didymosphenia geminata* in high risk sites. *NIWA Client Report CHC2006-053*. Prepared for Ministry of Agriculture and Forestry and Biosecurity New Zealand.

Edge K.-A., Crouchley D., McMurtrie P., Willans M.J., and Byrom A. 2011: Eradicating stoats (*Mustela erminea*) and red deer (*Cervus elaphus*) off islands in Fiordland. *In*: Veitch C.R., Clout M.N., and Towns D.R. (eds) Island invasives: eradication and management. pp. 166-171. IUCN, Gland, Switzerland.

Edmonds H. 2002 (draft): Anchor Island Restoration Plan. Department of Conservation Te Anau Area Office, Southland Conservancy. 25 pp.

Edmonds H. 2012 (draft): Taxon plan for northern and southern Fiordland tokoeka (*Apteryx australis australis*): Strategic plan for the recovery of northern and southern Fiordland tokoeka for the period 2012-2022 and beyond. Te Anau Area Office, Department of Conservation. Unpublished report.

Elliott G., Willans M., Edmonds H., and Crouchley D. 2010: Stoat invasion, eradication and reinvasion of islands in Fiordland. *New Zealand Journal of Zoology 37*: 1-12.

Environment Southland 2008: Operative Regional Coastal Plan for Southland. Amended based on Council and Environment Court Decisions, and the Fiordland Marine Management Act 2005. *Publication No. 2012-18*. Environment Southland, Invercargill.

Ewans R. and Lake S. 2011: Resolution Island Weed Management Strategy 2010-2020. *DOCDM-699070*. Department of Conservation Te Anau Area Office, Southland Conservancy.

Ewans R. 2010: Baseline vegetation outcome monitoring for deer control using seedling ratio index (SRI) on Resolution Island, Fiordland National Park. Unpublished Department of Conservation report.

Felix F. 1994: Ecology of the coastal bottlenose dolphin *Tursiops truncatus* in the Gulf of Guayaquil, Ecuador. *Ecology 25*: 235-256.

Freeman D.J., Marshall B.A., Ahyong S.T., Wing S.R., and Hitchmough R.A. 2010: Conservation status of New Zealand marine invertebrates, 2009. *New Zealand Journal of Marine and Freshwater Research 44*: 129-148.

Gaskin C.P. 2013: Important areas for New Zealand seabirds Part 2 - South Island & Rakiura IBA (land) boundaries review document. Forest and Bird and BirdLife International. DRAFT.

Gaskin C.P. and Rayner M.J. 2013: Seabirds of the Hauraki Gulf: natural history, research and conservation. Hauraki Gulf Forum, Auckland. 141p.

Gaze P.G. 2001: Tuatara recovery plan 2001-2011. *Threatened Species Recovery Plan Number 47*. Department of Conservation, Wellington.

Gibbs M.T. 2000: Aspects of the structure and variability of the low salinity layer in Doubtful Sound, a New Zealand fiord. *New Zealand Journal of Marine and Fresh Water Research 35*: 59-72.

Gill B.J., Bell B.D., Chambers G.K., Medway D.G., Palma R.L., Scofield R.P., Tennyson A.J.D., and Worthy T.H. 2010: *Checklist of the birds of New Zealand, Norfolk and Macquarie Islands, and the Ross Dependency, Antarctica, 4th Edition*. Te Papa Press in association with the Ornithological Society of New Zealand, Wellington. 500 pp.

Given D.R. 1973: Naturalised flowering plants in South-west Fiordland. *New Zealand Journal of Botany 11*: 247-250.

Goebel N.L. 2001: Temporal and spatial variability in phytoplankton biomass and production in Fiordland, New Zealand. *PhD Thesis.* University of Otago, Dunedin.

Goebel N.L., Wing S.R., and Boyd P.W. 2005: A mechanism for onset of diatom blooms in a fiord with persistent salinity stratification. *Estuarine Coastal and Shelf Science 64*: 546-560.

Guerra M. and Dawson S.M. in prep: Monitoring the effects of vessels on Bottlenose Dolphins in Fiordland, New Zealand. *Report for the Department of Conservation.* University of Otago, Dunedin.

Hardy G. 1977: The New Zealand Scincidae: a taxonomic study. *New Zealand Journal of Zoology 4*: 221-325.

Hasse P. and Schneider K. 2001: Birth demographics of bottlenose dolphins, *Tursiops truncatus*, in Doubtful Sound, Fiordland, New Zealand - preliminary findings. *New Zealand Journal of Marine and Freshwater Research 35*: 675-680.

Hawke D. and Holdaway R. 2005: Avian assimilation and dispersal of carbon and nitrogen brought ashore by breeding Westland petrels (*Procellaria westlandica*): a stable isotope study. *Journal of Zoology 266*: 419-426.

Hay C.H. and Luckens P.A. 19871: The Asian kelp *Undaria pinnatifida* (Phaeophyta: Laminariales) found in a New Zealand harbour. *New Zealand Journal of Botany 25*: 329-332.

Henderson J. and Goodman A. 2007: Management plan for western weka [Fiordland] *Gallirallus australis australis*: 2007-2012. Southland Conservancy, Department of Conservation. Unpublished report.

Henderson S.D. 2012: Habitat use, reproduction and survival: a comparative study of bottlenose dolphins in Doubtful Sound and Dusky Sound. *PhD Thesis.* University of Otago, Dunedin.

Hitchmough R., Anderson P., Barr B., Hoare J., Lettink M., Reardon J., Tocher M., and Whitaker T. In press: Conservation status of New Zealand reptiles, 2012. Department of Conservation, Wellington.

Hitchmough R., Bull L., and Cromarty P. (comp.) 2007: New Zealand Threat Classification System lists 2005. Science and Technical Publishing, Department of Conservation.

Hitchmough R.A., Hoare J.M., Jamieson H., Newman D., Tocher M.D., Anderson P.J., Lettink M., and Whitaker A.H. 2010: Conservation status of New Zealand reptiles, 2009. *New Zealand Journal of Zoology 37*: 203-224.

Holdaway R.J., Wiser S.K., and Williams P.A. 2012: Status assessment of New Zealand's naturally uncommon ecosystems. *Conservation Biology 26*: 619-629.

Holloway B. 2007: Lucanidae (Insecta: Coleoptera). *Fauna of New Zealand Number 61*. Manaaki Whenua Press, Lincoln.

Innes J. 2008: Predator control to limit island reinvasion and restore the mainland, eastern Bay of Islands. *Landcare Research Contract Report LC0809/048.* Prepared for Northland Regional Council, Whangarei.

Jack L. and Wing S.R. 2012: Individual variability in trophic position and diet of a marine omnivore is linked to kelp bed habitat. *Marine Ecology Progress Series 443*: 129-139.

Jack L. and Wing S.R. In press: A safety network against regional population collapse: mature subpopulations in refuges distributed across the landscape. *Ecosphere*.

Jack L., Wing S.R., and McLeod R.J. 2009: Prey base shifts in red rock lobster *Jasus edwardsi*i in response to habitat conversion in Fiordland marine reserves: implications for effective spatial management. *Marine Ecology Progress Series 381*: 213-222.

Jones H.P. and Kress S.W. 2012: A review of the world's active seabird restoration projects. *The Journal of Wildlife Management 76*: 2-9.

Jones M.E., Tennyson A.J.D., Worthy J.P., Evans S.E., and Worthy T.H. 2009: A sphenodontine (Rhynchocephalia) from the Miocene of New Zealand and palaeobiogeography of the tuatara (Sphenodon). *Proceedings of the Royal Society Biological Sciences* 276(1660): 1385-1390.

Kelly D., Ladley J.J., Robertson A.W, Anderson S.H., Wotton D.M. and Wiser S.K. 2010: Mutualisms with the wreckage of an avifauna: the status of bird pollination and fruit dispersal in New Zealand. *New Zealand Journal of Ecology 34*: 66-85.

Kilroy C., Snelder T., and Sykes J. 2005: Likely environments in which the non-indigenous freshwater diatom, *Didymosphenia geminata*, can survive, in New Zealand. *NIWA Client Report*: *CHC2005-043*. Prepared for Biosecurity New Zealand. (Map available at: http://www.biosecurity.govt.nz/pests/didymo/where-is-it).

Ledgard G., Rance B.D., Ewans R., and Lake S. 2011: Vegetation and flora inventory of Resolution Island, Fiordland National Park, New Zealand. Department of Conservation, Southland Conservancy, Invercargill. 60 pp.

Lee K.E. 1959: A key for the identification of New Zealand earthworms. *Tuatara 8*: 13-60.

Lemon M., Lynch T.P., Cato D.H., and Harcourt R.G. 2006: Response of travelling bottlenose dolphins (*Tursiops aduncus*) to experimental approaches by a powerboat in Jervis Bay, New South Wales, Australia. *Biological Conservation 127*: 363-372.

Leschen R.A.B., Marris J.W.M., Emberson R.M., Nunn J., Hitchmough R.A., and Stringer I.A.N. 2012: The conservation status of New Zealand Coleoptera. *New Zealand Entomologist 35*: 91-98.

Lusseau S. and Wing S. 2006: Importance of local versus pelagic subsidies in the diet of an isolated population of bottlenose dolphins (*Tursiops sp.*). *Marine Ecology Progress Series 321*: 283-293.

Mahlfeld K., Brook F.J., Roscoe D.J., Hitchmough R.A., and Stringer I.A.N. 2012: The conservation status of New Zealand terrestrial Gastropoda excluding *Powelliphanta*. *New Zealand Entomologist 35*: 103-109.

Marshall L. 2012: Dusky Sound Restoration Plan: Draft Outline. Department of Conservation, Te Anau Area Office. 7 pp.

Mawhinney M. 2003: Anchor Island Deer Control Plan. Department of Conservation Te Anau Area Office, Southland Conservancy

McCauley D.J., DeSalles P.A., Young H.S., Dunbar R.B., Dirzo R., Mills M.M., and Micheli F. 2012: From wing to wing: the persistence of long ecological interaction chains in less-disturbed ecosystems. *Scientific Reports 2*: 409.

McDowall R.M. and Frankenberg R.S. 1981: The galaxiid fishes of Australia (Pisces: Galaxiidae). *Records of the Australian Museum33*: 443-605.

McGuinness C.A. 2001: The conservation requirements of New Zealand's nationally threatened invertebrates. *Threatened Species Occasional Publication 20*. Biodiversity Recovery Unit, Department of Conservation, Wellington. 658 pp.

McLeod R.J. and Wing S.R. 2007: Hagfish populations in the New Zealand fiords are supported by chemoautotrophy of forest litter carbon. *Ecology 88*: 809-816.

McLeod R.J. and Wing S.R. 2009: Strong pathways for incorporation of terrestrially derived organic matter into benthic communities. *Estuarine, Coastal and Shelf Science 82*: 645-653.

McMurtrie P., Edge K.-A., Crouchley D., and Willans M. 2008: Resolution Island Operational Plan: Stoat Eradication. Department of Conservation, Invercargill. 45 pp.

Medway D.G. 2007. A possible live South Island snipe (Coenocorypha iredalei) at Dusky Sound in 1773. *Notornis 54*: 237-238.

Miller L.J., Solangi M., and II S.A.K. 2008: Immediate response of Atlantic bottlenose dolphins to high-speed personal watercraft in the Mississippi Sound. *Journal of the Marine Biological Association of the United Kingdom 88*: 1139-1143.

Miskelly C.M. and Baker A.J. 2009: Description of a new subspecies of *Coenocorypha* snipe from subantarctic Campbell Island, New Zealand. *Notornis 56*: 113-123.

Miskelly C.M. and Powlesland R.G. 2013: Conservation translocations of New Zealand birds, 1863-2012. *Notornis 60*: 3-28.

Miskelly C.M., Dowding J.E., Elliott G.P., Hitchmough R.A., Powlesland R.G., Robertson H.A., Sagar P.M., Scofield R.P., and Taylor G.A. 2008: Conservation status of New Zealand birds, 2008. *Notornis 55*: 117-135.

Miskelly C.M., Taylor G.A., Gummer H. and Williams R. 2009: Translocations of eight species of burrow-nesting seabirds (genera *Pterodroma*, *Pelecanoides*, *Pachyptila* and *Puffinus*: Family Procellariidae). *Biological Conservation 142*: 1965-1980.

Moles A.T. and Drake D.R. 1999: Post-dispersal seed predation on eleven large-seeded species from the New Zealand flora: a preliminary study in secondary forest. N*ew Zealand Journal of Botany 37*: 679-685.

Mulder C.P.H., Anderson W.B., Towns D.R. and Bellingham P.J. 2011: Seabird islands: ecology, invasion and restoration. Oxford University Press, Oxford.

Nelson W.A., Villouta E., Neill K.F., Williams G.C., Adams N.M., and Slivsgaard R. 2002: Marine macroalgae of Fiordland, New Zealand. *Tuhinga 13*: 117-152.

Nugent G., Fraser W., and Sweetapple P. 2001: Top down or bottom up? Comparing the impacts of introduced arboreal possums and 'terrestrial' ruminants on native forests in New Zealand. *Biological Conservation 99*: 65-79.

Newman D.G. 1996: Native frog (*Leiopelma* spp.) Recovery Plan. *Threatened Species Recovery Plan No. 18*. Department of Conservation, Wellington.

O'Connor S.M., Maloney R.F., and Pierce R.J. 2007: Pateke (*Anas chlorotis*) recovery plan, 2005-2010. *Threatened Species Recovery Plan 59*. Department of Conservation, Wellington. 33 pp.

O'Donnell C.F.J. 2000: Influence of season, habitat, temperature, and invertebebrate availability on nocturnal activity on the New Zealand long-tailed bat (*Chalinolobus tuberculatus*). *New Zealand Journal of Zoology 27*: 207-221.

O'Donnell C.F.J., Christie J.E., and Simpson W. 2006: Habitat use and nocturnal activity of lesser short-tailed bats (*Mystacina tuberculata*) in comparison with long-tailed bats (*Chalinolobus tuberculatus*) in temperate rainforest. *New Zealand Journal of Zoology 33*: 113-124.

O'Donnell C.F.J., Christie J.E., Corben C., Sedgeley J.A., and Simpson W. 1999: Rediscovery of short-tailed bats (*Mystacina* sp.) in Fiordland, New Zealand: Preliminary observations of taxonomy, echolocation calls, population size, home range, and habitat use. *New Zealand Journal of Ecology 23*: 21-30.

O'Donnell C.F.J., Dowding J.E., Hitchmough R.A., Lloyd B., and Parsons S. 2010: The conservation status of New Zealand bats, 2009. *New Zealand Journal of Zoology 37*: 297-311.

O'Donnell C.F.J., Edmonds H., and Hoare J.M. 2011: Survival of PIT-tagged lesser short-tailed bats (*Mystacina tuberculata*) through a pest control operation using the toxin pindone in bait stations. *New Zealand Journal of Ecology 35*: 291-295.

Oliver W.R.B. 1955: *New Zealand birds, 2nd Edition*. Reed, Wellington.

OSNZ 2010: Checklist of the birds of New Zealand and the Ross Dependency, Antarctica. Fourth Edition. The Checklist Committee (Dr Brian Gill, Convener) OSNZ. Te Papa Press in association with the Ornithological Society of New Zealand Inc.

Parijs S.M.V. and Corkeron P.J. 2001: Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, Sousa chinensis. J*ournal of the Marine Biological Association of the United Kingdom 81*: 533-538.

Peat N. and Patrick B.H. 1996: Wild Fiordland. University of Otago Press, Dunedin. 144 pp.

Polis G. and Hurd S. 1996: Allochthonous input across habitats, subsidized consumers, and apparent trophic cascades; examples from the ocean-land interface. Pp 275-285 *in* G. Polis and K. Winemiller, editors. *Food Webs*: *Integration of Patterns and Dynamics*. Chapman and Hall.

Pryde M.A, O'Donnell C.F.J., and Barker R.J. 2005: Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): Implications for conservation. *Biological Conservation 126*: 175-185.

Pryde M.A., Lettink M., and O'Donnell C.F.J. 2006: Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. *New Zealand Journal of Zoology 33*: 85-95.

Rance B. 2002: Anchor Island - vegetation report. Unpublished Department of Conservation report, Southland Conservancy.

Roberts A. 1994: South Island saddleback recovery plan (*Philesturnus carunculatus carunculatus*). *Threatened Species Recovery Plan Series No. 11*. Department of Conservation, Wellington. 26 pp.

Roberts A. 1999: Recovery plan for reptiles of Southland Conservancy. Department of Conservation, Invercargill. 26 pp.

Roberts A. and Miskelly C. 2003: Recovery plan for the snipe species of New Zealand and the Chatham Islands (*Coenocorypha* spp.) tutukiwi, 2003-2015. Department of Conservation, Wellington. 29 pp.

Robertson C.J.R., Hyvönen P., Fraser M.J., and Pickard C.R. 2007: Atlas of bird distribution in New Zealand 1999-2004. The Ornithological Society of New Zealand Inc, Wellington.

Robertson H.A. 2013: Tui. In Miskelly, C.M. (ed.) New Zealand Birds Online. www.nzbirdsonline.org.nz

Rodgers K.L. and Wing S.R. 2008: Spatial structure and movement of blue cod *Parapercis colias* in Doubtful Sound, New Zealand, inferred from $\delta^{13}C$ and $\delta^{15}N$. *Marine Ecology Progress Series 359*: 239-248.

Rowe L.E., Currey R.J.C., Dawson S.M., and Johnson D. 2010: Assessment of epidermal condition and calf size of Fiordland bottlenose dolphin *Tursiops truncatus* populations using dorsal fin photographs and photogrammetry. *Endangered Species Research 11*: 83-89.

Russ R.B., McLean I.G., and Studholme J.S. 1992: The Fiordland crested penguin survey, Stage II: Dusky and Breaksea Sounds. *Notornis 39*: 113-118.

Sánchez-Piñero, F. and Polis G. 2000: Bottom-up dynamics of allochthonous input: direct and indirect effects of seabirds on islands. *Ecology 81*: 3117-3132.

Sawyer S.L. and Fogle S.R. 2010: Acoustic attraction of grey-faced petrels (*Pterodroma macroptera gouldi*) and fluttering shearwaters (*Puffinus gavia*) to Young Nick's Head, New Zealand. *Notornis 57*: 166-168.

Scheffer V.B. 1958: Seals, Sea Lions and Walruses - A Review of the Pinnipedia. Stanford University Press, Stanford CA.

Schneider K. 1999: Behaviour and Ecology of Bottlenose Dolphins in Doubtful Sound, Fiordland, New Zealand. *PhD Thesis.* University of Otago, Dunedin, New Zealand.

Sedgeley J.A. and O'Donnell C.F.J. 1999: Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. *Biological Conservation* 88: 261-276.

Shears N.T. and Babcock R.C. 2002: Marine reserves demonstrate top-down control of community structure on temperate reefs. *Oecologia 132*: 131-142.

Silva P.C., Woodfield R.A., Cohen A.N., Harris L.H., and Goddard J.H.R. 2002: First report of the Asian kelp *Undaria pinnatifida* in the northeastern Pacific Ocean. *Biological Invasions 4*: 333-338.

Smart A. 2007: Mohua/yellowhead and kakaruai/South Island robin reintroduced to Pigeon Island, Dusky Sound. *Fiordland Coastal Newsletter October 2007*. Department of Conservation, Invercargill. 4 pp.

Smith F. and Witman J.D. 1999: Species diversity in subtidal landscapes: Maintenance by physical process and larval recruitment. *Ecology 80*: 51-69.

Smith I.W.G. 2002: The New Zealand sealing industry : history, archaeology, and heritage management. Department of Conservation, Wellington. 72 pp.

Stanton B. and Pickard G. 1981: Physical oceanography of New Zealand fiords. *New Zealand Oceanographic Institute Memoirs 88*: 3-37.

Stensland E. and Berggren P. 2007: Behavioural changes in females Indo-Pacific bottlenose dolphins in response to boat-based tourism. *Marine Ecology Progress Series 332*: 225-234.

Stringer A.N., Hitchmough R.A., Dugdale J.S., Edwards E., Hoare R.J.B., and Patrick B.H. 2012: The conservation of New Zealand Lepidoptera. *New Zealand Entomologist 35*(2): 120-127.

Stuart M.D. 2003: Review of research on *Undaria pinnatifida* in New Zealand and its potential impacts on the eastern coast of the South Island. *DOC Scientific Internal Series 166*. Department of Conservation, Wellington. 40 pp.

Sweetapple P.J., Nugent G., Whitford J. and Knightbridge P.I. 2002: Mistletoe (Tupeia Antarctica) recovery and decline following possum control in a New Zealand forest. *New Zealand Journal of Ecology 26*: 61-71.

Taylor R. 1988: Rat eradication in Breaksea Sound. *Forest and Bird 19*: 30-34.

Taylor R.H. and Thomas B.W. 1989: Eradication of Norway rats (*Rattus norvegicus*) from Hawea Island, Fiordland, using brodifacoum. *New Zealand Journal of Ecology 12*: 23-32.

Teirney L. 2003: Fiordland Marine Conservation Strategy. Te Kaupapa Atawhai o Te Moana o Atawhenua. Guardians of Fiordlands's Fisheries and Marine Environment Inc.

Thakur S. 2011: Transfer of Snares Island snipe/tutukiwi (*Coenocorypha huegeli*) from The Snares/Tini Heke to Anchor Island/Puke Nui. March 2011. Te Anau Area Office, Department of Conservation. Unpublished translocation proposal.

Thomas B. 1996: Working with weevils: Conservation of the less-than-cute'n'cuddly is carried out in the remoter parts of the South Island. *New Zealand Science Monthly Online*: *November 1996*.

Thomas B.W. 2002: Ecological restoration of islands in Breaksea Sound, Fiordland, New Zealand. *In*: Veitch C.R. and Clout M.N. (eds.) Turning the Tide: The Eradication of Invasive Species. Proceedings of the International Conference on the Eradication of Island Invasives. *Occasional Paper of the IUCN Species Survival Commission No. 27*. p. 414. IUCN, Gland, Switzerland.

Thomas B.W. and Taylor R.H. 2002: A history of ground-based rodent eradication techniques developed in New Zealand, 1959-1993. *In*: Veitch C.R. and Clout M.N. (eds.) Turning the Tide: The Eradication of Invasive Species. Proceedings of the International Conference on the Eradication of Island Invasives. *Occasional Paper of the IUCN Species Survival Commission No. 27*. pp. 301-310. IUCN, Gland, Switzerland and Cambridge, UK.

Thomas B.W. and Whitaker A.H. 1994: Translocation of the Fiordland skink *Leiolopisma acrinasum* to Hawea Island, Breaksea Sound, Fiordland, New Zealand. *In*: Serena M. (ed). Reintroduction biology of Australian and New Zealand fauna. pp. 91-95. Surrey Beatty and Sons, Chipping Norton, Australia.

Thomas B.W., Meads M.J., and Notman P.R. 1992: A report on the restoration of knobbled weevil (*Hadramphus stilbocarpae*) and flax weevils (*Anagotus fairburni*) to Breaksea Island, Breaksea Sound, Fiordland. *DSIR Land Resources Technical Record 79*.

Tocher M.D., Jewell T., and Goodman A. 2005: Kathmandu alpine gecko survey results 2004/2005. Unpublished report to Southland Conservancy, Department of Conservation.

Towns D.R. and Daugherty C.H. 1994: Patterns of range contractions and extinctions in the New Zealand herpetofauna following human colonization. *New Zealand Journal of Zoology 21*: 325-339.

Turnbull I.M., Allibone A.H., and Jongens R. (comp.) 2010: Geology of the Fiordland area. Institute of Geological and Nuclear Sciences 1:250 000 Geological Map 17. GNS Science, Lower Hutt. 97 pp. plus map.

Turnbull I.M., Lindqvist J.K., Mildenhall D.C., Hornibrook N. de B., Beu A.G., and Mildenhall D.C. 1985: Stratigraphy and paleontology of Pliocene - Pleistocene sediments on Five Fingers Peninsula, Dusky Sound, Fiordland. *New Zealand Journal of Geology and Geophysics 28*: 217-231.

Valintine J.P. and Johnson C.R. 2003: Establishment of the introduced kelp *Undaria pinnatifida* in Tasmania depends on disturbance to native algal assemblages. *Journal of Experimental Marine Biology and Ecology 295*: 63-90.

Visser F., Hartman K.L., Rood E.J.J., Hendriks A.J.E., Zult D.B., Wolff W.J., Huisman J., and Pierce G.J. 2011: Risso's dolphins alter daily resting pattern in response to whale watching at the Azores. *Marine Mammal Science 27*: 366-381.

Walker K. 2003: Recovery plans for *Powelliphanta* land snails 2003-2013. *Threatened Species Recovery Plan 49*. Department of Conservation, Wellington. 208 pp plus 64 plates.

Ward C.M. 1984: Geology of the Dusky Sound area, Fiordland, with emphasis on the structural-metamorphic evolution of some porphyroblastic staurolite pelites. *Unpublished PhD thesis*. University of Otago, Dunedin.

Wickes C. and Edge K.-A. 2009 (updated 2012): Secretary and Resolution Islands Restoration Plan. Unpublished draft report, Department of Conservation, Southland Conservancy.

Wickes C., Crouchley D., and Maxwell J. 2009: Takahe (*Porphyrio hochstetteri*) recovery plan 2007-2012. *Threatened Species Recovery Plan 61*. Department of Conservation, Wellington.

Wildland Consultants 2010: A review of tawaki population trend monitoring in South Westland, Fiordland, and on Whanua Hou 1990-2008. *Wildland Consultants Contract Report No. 2253*. Prepared for Department of Conservation, West Coast Conservancy. 46 pp.

Willans M. 2013 (In prep.): Rock wren translocation to Secretary Island. Te Anau Area Office, Department of Conservation, unpublished report.

Willans M. 2013 (In draft): Kokako translocation to Secretary Island: update 2013 and preliminary analysis. Te Anau Area Office, Department of Conservation, unpublished report.

Williams P.A., Wiser S., Clarkson B., and Stanley M. 2007: New Zealand's historically rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31*: 119-128.

Willis T.J., Handley S.J., Page M.J., Bradley A., Cairney D., D'Archino R., and Blakemore K. 2010: Fiordland (Te Moana o Atawhenua) Marine Area China Shops Survey 2009. *Report for the Department of Conservation*. NIWA, Nelson.

Willis T.J., Handley S.J., Page M.J., Cairney D.G., and D'Archino R. 2009: Fiordland (Te Moana o Atawhenua) Marine Area Monitoring Survey 2008/2009. *Report for the Department of Conservation*. NIWA, Nelson.

Wilson D.J., Wright E.F., Canham C.D., and Ruscoe W.A. 2007: Neighbourhood analyses of tree seed predation by introduced rodents in a New Zealand temperate rainforest. *Ecography 30*: 105-119.

Wing S., Lamare M., and Vasques J. 2001: Population structure of sea urchins (*Evechinus chloroticus*) along gradients in primary productivity in the New Zealand fiords. *In*: Barker M. (ed). Echinoderms. p. 575. Balkema, Dunedin.

Wing S., Leichter J., Perrin C., Rutger S., Bowman M., and Cornelisen C. 2007: Topographic shading and wave exposure influence morphology and ecophysiology of *Ecklonia radiata* (C. Agardh 1817) in Fiordland, New Zealand. *Limnology and Oceanography 5*: 1853-1864.

Wing S.R. 2009: Population networks with sources and sinks along productivity gradients in the Fiordland Marine Area, New Zealand: a case study on the sea urchin, *Evechinus chloroticus*. *In*: Lui J., Weins J., Hull V., and Morzillo A. (eds). Sources, Sinks and Sustainability. Cambridge University Press.

Wing S.R. and Jack L. 2007: Biological Monitoring of the Fiordland (Te Moana o Atawhenua) Marine Area and Fiordland's Marine Reserves - 2007 (*2 of 2*). Report for the Department of Conservation, Southland NZ. University of Otago, Dunedin.

Wing S.R. and Jack L. In press: Marine reserve networks conserve biodiversity by stabilizing communities and maintaining food web structure. *Ecosphere*.

Wing S.R., and Jack L. 2010: Biological Monitoring of the Fiordland (Te Moana o Atawhenua) Marine Area and Fiordland's Marine Reserves - 2010. Report for the Department of Conservation, Southland NZ. University of Otago, Dunedin.

Wing S.R., Beer N.A., and Jack L. 2012: Resource base of blue cod *Parapercis colias* subpopulations in marginal fiordic habitats is linked to chemoautotrophic production. *Marine Ecology Progress Series 466*: 205-214.

Wing S.R., Bowman H., Smith F., and Ruthger S. 2005: Analysis of biodiversity patterns and management decision making processes to support stewardship of marine resources and biodiversity in Fiordland - a case study (*Report 3 of 3*). Ministry for the Environment, Wellington.

Wing S.R., McLeod R.J., Clark K.L., and Frew R.D. 2008: Plasticity in diet of two echinoderm species across an ecotone: microbial recycling of forest litter and bottom-up forcing of population structure. *Marine Ecology Progress Series 360*: 115-123.

Witman J.D. and Grange K.R. 1998: Links between rain, salinity and predation in a rocky subtidal community. *Ecology 79*: 2429-2447.

Würsig B. and Würsig M. 1979: Behavior and ecology of the bottlenose dolphin, *Tursiops trucatus,* in the South Atlantic. *Fishery Bulletin 77*: 399-412.

EARLY HUMAN HISTORY OF DUSKY SOUND

Recorded Archaeological Sites from Archsite, the NZ Archaeological Association Site Recording Scheme. http://www.archsite.org.nz/

NZAA Site Number	Island/Site	Site Description	Easting (NZTM)	Northing (NZTM)	Location Notes
A44/1	Pigeon	Historic hut site	1098125	4918250	
A44/2	Resolution	Shipwreck	1099327	4919254	
A44/3	Anchor	Hut sites	1096331	4911729	
A44/4	Anchor	Shipbuilding site	1096331	4911729	
A44/5	Resolution	Māori hut site	1099327	4918853	
A44/6	Resolution	Māori hut site	1097919	4921558	
A44/7	Resolution	Māori huts	1097614	4924365	
A44/8	Resolution	Māori hut	1097613	4924666	
A44/9	Anchor	Occupation site	1096930	4913335	
A44/10	Anchor	Ovens	1095729	4912430	
A44/11	Passage	Occupation site, artefacts	1099941	4911836	
A44/12	Pigeon	Ovens	1098125	4918250	
A44/14	Resolution	Hut site	1097919	4921759	
A44/15	Anchor	Try pot site	1097031	4912733	
A44/16	Stop	Shipwreck	1098036	4911833	
A44/17	Resolution	House site	1097919	4921558	
A44/18	Anchor	Burial	1093224	4911423	
A44/19	Pigeon	Fireplaces	1098425	4918451	
A44/20	Resolution	Historic camp	1099226	4919254	
A44/22	Anchor	Barked totara	1097032	4912232	
A44/23	Anchor	Historic landing	1096231	4911629	
A44/25	Stop	Historic camp	1098036	4911732	
A44/26	Passage	House terrace	1099740	4911936	
A44/27	Anchor	Historic hut site	1096432	4911629	
A44/28	Anchor	Historic hut site	1096332	4911529	
A44/29	Anchor	Historic terrace	1096432	4911629	
A44/30	Resolution	Historic terrace	1099327	4919154	
B43/5	Unnamed island north of Chatham point, Vancouver Island, Breaksea Sound	Midden	1122554	4938941	
B43/7	Unnamed island north of Chatham point, Vancouver Island, Breaksea Sound	Rockshelter	1122554	4938941	
B43/8	Unnamed island north of Chatham point, Vancouver Island, Breaksea Sound	Cave with midden	1122554	4938941	
B44/1	Long	Rockshelter	1103753	4910740	
B44/2	Long	Hut, artefacts	1108161	4912753	
B44/3	Indian	Midden	1102349	4910837	
B44/4	Long	Midden	1103753	4910339	
B44/5	Resolution	Barked totara	1101136	4916651	
B44/6	Indian	Possible ovens	1102449	4911138	
B44/7	Mainland	Brewery	1100649	4908428	Pickersgill
B44/8	Mainland	Wales observatory	1100648	4908528	Pickersgill
B44/9	Resolution	Māori huts	1101136	4916651	

NZAA Site Number	Island/Site	Site Description	Easting (NZTM)	Northing (NZTM)	Location Notes
B44/10	Mainland	Māori camp site	1100649	4908328	Pickersgill
B44/11	Mainland	Observatory site	1106048	4916860	Pickersgill
B44/14	Long	Rockshelter with midden	1105056	4910642	
B44/16	Indian	Pits	1102448	4911239	
B44/18	Mainland	Historic camp	1129304	4917801	Near Shark Cove
B44/19	Long	Rockshelters	1113570	4915168	
B44/20	Cooper	House sites	1118080	4915978	
B44/21	Long	Settlement site	1129899	4921711	
B44/22	Cooper	Rockshelter	1116876	4916577	
B44/23	Mainland	Chopped totara	1134911	4921319	Seaforth river
B44/24	Resolution	Māori huts	1106127	4929994	
B44/25	Mainland	Rockshelter	1129782	4932135	Wetjacket Arm
B44/26	Long	Overhang and midden	1103953	4911041	
B44/27	Resolution	Overhang and midden	1100227	4920158	
B44/28	Mainland	Historic hut	1100649	4908328	Pickersgill
B44/29	Resolution	Barked totara	1101337	4916350	
B44/32	Resolution	Hut site	1105449	4915355	
B44/33	Resolution	Sealer s boat run	1105249	4915154	
B44/34	Useless	Cave with midden	1100640	4913441	
B44/35	Resolution	Rockshelter	1102641	4915651	
B44/36	Resolution	Barked totara	1102541	4915550	
B44/37	Resolution	Watering place	1100333	4916850	
B44/38	Mainland	Historic hut	1119777	4920291	Opposite Cooper
B44/40	Mainland	Historic hut	1122396	4912978	Fanny Bay
B44/41	Mainland	Rockshelter	1122457	4936735	Broughton Arm
B44/42	Mainland	Mine and campsite	1122773	4926912	Wetjacket Arm
B45/1	Mainland	Rockshelter	1102054	4907227	Cascade Cove
B45/2	Mainland	Hut sites	1100451	4907024	Cascade Cove
B45/3	Mainland	Sealing camp	1101954	4907328	Cascade Cove
B45/28	Mainland	Cave with midden	1101954	4907328	Cascade Cove

Interpretation of data from the New Zealand Archaeological Association's Archaeological Site Recording Scheme

ArchSite is an online database that contains information about recorded archaeological sites in New Zealand. *ArchSite* uses GIS (Geographic Information System) technology to manage and display information on maps. It is the national inventory of archaeological sites in New Zealand. The information is used for research, site management and protection. There are currently over 60,000 sites in *ArchSite*.

ArchSite incorporates information from the NZ Archaeological Association's Site Recording Scheme. The Site Recording Scheme began over fifty years ago as a paper-based recording system for information about archaeological sites. Information has been provided by many different individuals and organisations over the years.

All information is provided on the strict understanding that the New Zealand Archaeological Association and any person or organisation associated with the Site Recording Scheme shall not be held liable in respect of any omissions from, or errors in, the data provided.

The following features of the data should be noted:

- A grid reference gives the location of a site, but it does not delimit its extent. The location of sites is usually only recorded to within about the nearest 100 metres. A more precise location may be given if a handheld GPS was used, but all such measurements have a standard error.

- *The absence of data for any particular area should not be taken to mean that it contains no archaeological sites.* It may mean that no archaeological survey has been carried out, or that sites were obscured at the time the survey was done. In any given area there may be any number of undiscovered or unrecorded sites.

- Some recorded sites may no longer exist. (They may, for example, have been destroyed since they were recorded.)

- Historical (post-European contact period) archaeological sites, in particular, are currently under-represented in *ArchSite*.

- Not all sites recorded in *ArchSite* are archaeological sites in terms of the Historic Places Act 1993. They may, for example, post-date 1900 or no longer be able, through investigation by archaeological methods, to provide evidence relating to the history of New Zealand.

- The formal evaluation of site significance is not a function of the Archaeological Site Recording Scheme.

- While some archaeological sites may also be considered wahi tapu, the Archaeological Site Recording Scheme is not specifically concerned with such places. If information about wahi tapu is required, it should be obtained from the relevant iwi.

- Information about vulnerable burial sites will, in some circumstances, be withheld.

For many purposes, an inspection by a qualified archaeologist will be required. Information from the Archaeological Site Recording Scheme is not a substitute for this.

APPENDIX 2

TRANSLOCATIONS AT DUSKY SOUND

References:

Thomas (2002), Colbourne (2005), Smart (2007), Department of Conservation (2010), Reintroduction Specialist Group Oceana Section http://rsg-oceania.squarespace.com/nz/, Fiordland Conservation Trust http://www.fiordlandconservationtrust.org.nz, and Department of Conservation http://www.doc.govt.nz, and Kakapo Recovery http://www.kakaporecovery.org.nz.

Species	Year	No.	From	To
Mostly kakapo, southern tokoeka, and little spotted kiwi	1897-1908	400-500	Mainland, often the Cascade Cove area	Resolution Island Long Island Indian Island Parrot Island Harbour Island Prove Island Noman Island Breaksea Island Cooper Island
South Island robin (*Petroica australis australis*)	1987		?	Breaksea Island
	2002	24	Breaksea Island	Anchor Island
	2004	32	Breaksea Island	Anchor Island
	2007	31	Anchor Island and Breaksea Island	Pigeon Island
	2013	71	Breaksea Island	Indian Island
Knobbled weevil (*Hadramphus stilbocarpae*)	1991	40	Outer Gilbert Island III	Breaksea Island
Flax weevil (*Anagotus fairburni*)	1991	20	Wairaki Island	Breaksea Island
Tieke/South Island saddleback (*Philesturnus carunculatus*)	1992	60	Big Island and Kundy Island	Breaksea Island
	2002	31	Breaksea Island	Anchor Island
	2004	24	Breaksea Island	Anchor Island
Mohua/yellowhead (*Mohoua ochrocephala*)	1995	32	Blue Mountains	Breaksea Island
	2002	24	Breaksea Island	Anchor Island
	2007	29	Anchor Island and Breaksea Island	Pigeon Island
	2011	60	Landsborough Valley	Resolution Island
Kakapo (*Strigops habroptila*)	1987		Rakiura	Whenua Hou
	2005		Pearl Island, Chalky Island	Anchor Island
	2012		?	Little Barrier Island
Rock wren (*Xenicus gilviventris*)	2005	24+	Murchison Mountains	Anchor Island
Fiordland skink (*Oligosoma acrinasum*)	1988		Wairaki Island	Hawea Island

Islands within the Dusky Sound project area have also acted as sources for species translocations elsewhere e.g. in March 2010, 50 South Island robin were transferred from Breaksea Island and Anchor Island to Passage Islands and Chalky Island in Chalky Inlet.

APPENDIX 3

PEST ANIMAL ERADICATIONS AT DUSKY SOUND

Island	Species	Year	Methods	Notes
Hawea	Norway rats	1986	Talon 50 WB (brodifacoum) in 73 bait stations (400 mm long, 100 mm diameter, non-perforated plastic "Nova-coil" pipe) distributed at about 40 m intervals. Checking stations, snap trapping, placing of apples, and searching for sign to confirm eradication (Taylor and Thomas 1989)	
Breaksea	Norway rats	1988	743 brodifacoum bait stations 50 m apart (25 m on main ridges) on tracks at 60 m vertical intervals. Six large stations were positioned by helicopter on inaccessible cliffs and offshore stacks. Follow-up monitoring for two years confirmed that rats had been eradicated (Thomas and Taylor 2002). As a precaution, South Island robins were transferred to Hawea Island prior to the operation	
Anchor	Stoats	2001	MkIV Fenn traps in wire, wood, and aluminium tunnels. 161 tunnels at 150 m intervals. Pre-baiting and baiting with eggs and meat (McMurtrie *et al*. 2008)	Stoat sighted in 2007 resulting in removal of 10 female kakapo.
Anchor	Red deer	2002-2007	Ground hunters with dogs. Week-long trips by a team of 5-10 hunters, with a total of 24 trips being completed over the period 2002 to 2007. One deer shot from helicopter. From 2004, barrier fences were used in an attempt to confine deer to trails. Checks of the island in December 2008 and December 2009 found no deer (Crouchley *et al*. 2011). Nine permanent 20 × 20 m plots were established before deer eradication began in 2002. The plots have been remeasured once in 2007 (Ledgard *et al*. 2008).	
Parrot	Stoats	2005	6 double MkIV™ Fenn sets	Infrequent stoat captures since 2000.
Pigeon	Stoats	2005	27 double MkIV™ Fenn sets	No stoats caught since July 2005.
Resolution	Stoats	2008	Stainless steel DOC 150™ kill traps as single-sets in a combination of wooden and wire tunnels. Over 2,300 trap tunnels were laid out across a 200 km track network, yielding a density of one tunnel per 9 ha across the island. Traps were baited with a single hen's egg and meat bait. A pre-baiting programme was undertaken before trapping commenced in mid-winter, when alternative food supplies for stoats would have been at their lowest (http://www.doc.govt.nz)	
Indian	Rodents	2010	Two aerial drops of rat poison on Indian and its stepping stone islands. Perimeter of bait stations and traps re-baited six monthly to keep stoats from re-establishing on the Island (http://www.fiordlandconservationtrust.org.nz)	DOC for Fiordland Conservation Trust in partnership with Fiordland Ecology Holidays, Ultimate Hikes and several other donors

APPENDIX 4

OTHER PEST ANIMAL CONTROL OPERATIONS

Stoat traps currently on islands surrounding Resolution Island and their capture history (Peter McMurtrie pers. comm. May 2013).

Location	Number and Type of Trap	Area (ha)	Capture History
Breaksea Sea Island	3 double set tunnels Doc 150's.	152	No captures since Dec 2000.
Hawea Island	2 double set tunnels DOC 150's.	9	No stoats caught since Dec 2000.
Gilbert Islands	5 double set tunnels DOC 150's.	25.4	Regular stoat captures since Dec 2000. Nothing caught since 2009 after trapping commenced on Resolution Island.
Entry Island	4 double set tunnels DOC.	38	One stoat caught in May 2001 since trapping 2000.
Front Island	2 double set tunnels DOC 150's.	1	No stoats caught since Dec 2000.
Fixed Head Island	4 double set tunnels DOC 150's.	22.4	Regular stoat captures since Dec 2000. Since 2008 Resolution Island trapping, nothing caught since 2009.
Useless Island	2 double set tunnels DOC 150's.	3.2	Regular stoat captures since Dec 2000. Since 2008 Resolution Island trapping.
Curlew Island	2 double set tunnels DOC 150's.	12	Only set in May 2013.
Long Island	300 double set tunnel DOC 150's.	1,899	40 established in 2008 and remainder 2012/13. Regular captures to date.
Two Sisters	5 single set tunnels and 1 rodent motel (Doc 150).		Occasional rodent captures.
Anchor Island	100 double set tunnels and 2 rodent motels (DOC 150's.	1,132	No stoat caught since 2001. Sighting 2007 nothing caught.
Nomans Island	2 double set tunnels DOC 150's.	20	No stoats caught since Dec 2000.
Thrum Cap Island	3 double set tunnels DOC 150's.	4	No stoats caught since Dec 2000.
Stop Island	3 double set tunnels DOC 150's.	10	No stoats caught since Dec 2000.
Prove Island	4 double set tunnels DOC 150's.	8	No stoats caught since Dec 2000.
Passage Island	4 double set tunnels DOC 150's.	18	No stoats caught since Dec 2000.
Many Islands	4 double set tunnels DOC 150's.	32	No stoats caught since Dec 2000.

Location	Number and Type of Trap	Area (ha)	Capture History
Petrel Island	2 double set tunnels DOC 150's.	28	No stoats caught since Dec 2000.
Cormorant Island	4 double tunnels DOC 150's.	13.5	Infrequent stoat captures since 2000. Stoat caught May 2001 and Nov 2003 Since 2008 Resolution trapping Nothing caught.
Indian Island	27 Single sets DOC 150's and 200's. Also 10 Rodent motels contain DOC 150's and mouse traps.	167	Regular stoat captures since Dec 2000. Occasional stoat captures since 2010 as trapping on the end of Long Island following Indian Rodent eradication.
Parrot Island	4 double tunnels DOC 150.	40	Infrequent stoat captures since 2000 Nothing caught since 2008 resolution trapping.
Pigeon Island	33 single set tunnels DOC 150's.	70	No stoats caught since July 2005 Nothing caught since 2008 resolution trapping.

Notes

- Earlier trapped island (Dec 2000) started as Fenn MkIV but were changed to DOC 150s.
- Mainland trapping adjacent to Resolution Island (Acheron Passage) 76 double set DOC 150s.
- Resolution Island as a total of 2350 single set DOC 150s.

ACCIDENTAL DISCOVERY PROTOCOL FOR FIORDLAND ISLAND PROJECTS

Why do we need to be careful and what should we look for?

Human Remains
The appearance of human remains in the form of bones could occur unexpectedly in many locations, through erosion or natural processes. Such remains are of considerable spiritual significance, and may also reveal valuable information about the past. There is also always the possibility that they could be the result of homicide. For these reasons such discoveries must be handled with care. Such remains must not be disturbed in any way.

Artefacts
All artefacts are protected under the Protected Objects Act and/or the National Parks Act. Artefacts (i.e. moveable objects) provide vital clues for understanding the human past, and often are great treasures/taonga for present and future generations. Considerable understanding and knowledge of artefacts can be lost if their origin is unknown and if their original location within a site is not adequately recorded. It is important that artefacts be handled in a manner befitting their importance, and ensuring they are not damaged.
In addition artefacts often constitute an integral part of an historic site and it may be more appropriate that they remain at the site. For these reasons it is generally desirable for them to remain in their original location either indefinitely, or until their context has been appropriately recorded.
However, there are exceptions to this. Some artefacts that come to light are extremely vulnerable to the effects of decay, and in other cases may be uplifted by members of the public or collectors if they are left in high use areas.

Archaeological Sites
Many unrecorded historic heritage sites will only be found by chance so it is essential that staff are alert to signs that may indicate their presence, and that they gather adequate information on the spot. The evidence of human activity within a natural environment is often subtle, and the effects of natural deterioration and revegetation further disguise physical remains. However, in most cases observant staff familiar with the natural environment will be able to recognise features that are out of context or indicate human activity.

It is important that such finds are recorded so that these sites can be given adequate protection, or active management if required.

All staff should be alert and report:

- Any unnatural ground formations: (ex. holes; pits; straight and squared off water-courses; flat areas; cleared pathways; formed steps;
- Any natural features out of their usual context such as: stones in stacks, circles, or other unnatural formation; dead vegetation stacked or shaped; introduced plant species that may have been part of gardens, farming, or could be spread by livestock; native species that

have been marked in any way (such as de-barked sections or drawings); artefacts of pre-European or European origin; shells of seafood species in piles, or layers in eroding banks; layers of charcoal;

- Any items of human manufacture such as metals, plastics, concrete, worked timber, glass, brick

Protocol
In the event that any discovery is made by staff in the field, **All work in the vicinity that could impact the discovery should cease immediately**

Step One: Information Gathering
The following information will be required:
- Grid reference from GPS in NZTM or with map number and edition
- Date of the discovery
- Name of person making the discovery, and contact details
- Aids to relocation of the site - a precise description
- Description of exactly what was seen
- If what is seen appears to be part of a site/larger site, provide a description of the site
- A site or location sketch including a north point and reference to some fixed landmark or feature
- Photographs showing details and context. These are particularly important for potential human remains and artefacts where decisions may need to be made without a site visit.

Do not touch or move anything.

Step Two: First Contacts
The following people should be contacted immediately or as soon as possible:
- *[the responsible project manager or supervisor in the Te Anau Area Office]*

Step Three: Subsequent Contacts
This person will then advise and seek advice from a Technical Advisor for heritage from the Science and Technical Unit.
The relevant people from the following list will be notified or become involved as appropriate:
- Local Police (if the find is human remains)
- The appropriate Runanga representative (for human remains or if the find potentially relates to Māori occupation or activity)
- NZHPT Regional Archaeologist (for human remains, or if the find is potentially pre-1900 and a site has been damaged).
- NZAA District Filekeeper (to add information to site recording scheme)
- Ministry for Culture and Heritage (for artefacts, within 28 days of the find)

Step Four: Decision-Making for human remains
The contact people identified above will then manage the situation. An archaeologist from or approved by the NZHPT will establish if the remains are archaeological or not, and record them. An archaeological authority will be required for disinterment and/or reinterment of human remains. If the human remains are still in the place of burial when they are found a licence may be required from the Health Department to reinter them. Ko Iwi Tangata will be handled in accordance with Iwi wishes and protocols.

Step Five: Management of artefacts

- It is preferable to leave most items in the location where they are found, especially if specialist Staff can revisit them within a short period of time.
- In some circumstances it may be advisable to collect the object and bring it back to the office. The criteria for uplifting the item are as follows:
  - Threat as a result of high visitation
  - Located in unstable land, i.e. eroding banks, sand dunes, land slips.
  - Of a delicate nature and obviously susceptible to damage or deterioration if they are left (i.e. timber, textile, or bone).
  - Rare or unusual items in locations where staff are unlikely to visit again for some time, or where items are vulnerable to being taken by visitors.

Advice should be sought by radio if possible, before any action is taken.

All items retrieved must be lodged with an appropriate repository (such as a museum) where they will be secure and receive the appropriate conservation treatment, they will be adequately recorded, and their custody determined by the Ministry of Culture and Heritage, in consultation with Iwi where relevant.

Call Free 0508 WILDNZ
Ph: +64 7 343 9017
Fax: +64 7 3439018
ecology@wildlands.co.nz

99 Sala Street
PO Box 7137, Te Ngae
Rotorua 3042,
New Zealand

Regional Offices located in
Auckland, Hamilton, Tauranga,
Whakatane, Wellington,
Christchurch and Dunedin

ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

www.wildlands.co.nz