New Zealand marine protected areas

Gaps analysis

Department of Conservation, Ministry for the Environment, Ministry for Primary Industries, 2019.

Department of Conservation
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Cover: Blue maomao with cabbage coral, Kermadec Islands. *Photo: James Marsden*

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Contents

1 Abstract

This report provides an analysis of the representativity and replication of broad-scale coastal and marine habitats in New Zealand's marine protected areas (MPAs). For the purposes of this report, MPAs are marine reserves and type 2 MPAs.

Marine reserves currently cover 9.8% of New Zealand's territorial sea, of which 0.4% is around the mainland and 9.4% is around outlying islands. A further 2.6% of the territorial sea is protected in type 2 MPAs.

New Zealand has 14 distinct bioregions that have differing ecology and physical characteristics – nine around mainland and five around outlying islands. Two bioregions (Kermadec Islands and Subantarctic Islands) have all of their territorial sea in MPAs but three bioregions (Snares, Three Kings and Chatham Islands) have no MPAs.

All bioregions (apart from Kermadec and Subantarctic Islands) have significant gaps in their habitat representation and replication in MPAs. The area of mainland bioregions contained in an MPA ranges from 0.3–4.7%.

The New Zealand Coastal Classification and Mapping Scheme identified 416 habitat types within New Zealand's territorial sea– 70% of these have less than 1% of their area in an MPA. Nine bioregions have less than half of their habitats represented in an MPA.

In mainland bioregions, 54% of the habitats had no representation in an MPA; 68% of the habitats had no representation in a marine reserve. For the habitats in mainland bioregions with at least 1% of their extent in an MPA, the proportion of habitats ranged from 17% (East Coast South Island) to 42% (North Cook Strait) of the total number of habitats. Likewise, between 11% (Southern South Island) and 32% (West Coast South Island) of the habitats in mainland bioregions had at least 1% of their extent within a marine reserve.

The replication of habitat types in MPAs was generally low and several bioregions had none of their habitats replicated in another MPA. Only four bioregions (Fiordland, North Eastern, West Coast South Island and Subantarctic Islands) had some of their habitats replicated in two or more marine reserves.

Several important caveats apply to this gaps analysis, including:

- The analysis does not account for any biodiversity outside MPAs that may be acting as a source of recruits or contributing to the connectivity of the MPAs.
- The analysis is limited to marine reserves and type 2 MPAs, and other protection measures are in place around New Zealand.
- The analysis was largely based on the presence or absence of habitats within MPAs and their spatial extent, irrespective of the type of habitat, its condition or aspects such as its patchiness.
- Most existing MPAs were not established in line with the broad-scale habitat classification scheme used in this analysis, and the classification scheme has some limitations.

This analysis provides one data element to inform discussions around the next steps for developing a representative network of MPAs in New Zealand's coastal and marine environment. Other aspects, such as ecological, cultural, economic and social considerations would also need to be considered as part of a robust MPA network design process.

2 Introduction

2.1 Definitions

Territorial sea

New Zealand's territorial sea extends 12 nautical miles from the coast.

Marine biogeographic regions (or bioregions) and habitats

According to New Zealand's Coastal Classification and Mapping Scheme (see below), New Zealand has 14 distinct bioregions (Figure 1) with differing ecology and physical characteristics. Bioregions are identified as mainland (nine) and outlying islands (five), with the outlying islands bioregions being: Kermadec Islands, Three Kings Islands, Chatham Islands, Snares Islands and Subantarctic Islands. Across all 14 bioregions, there are calculated to be 416 distinct habitat types. Examples of habitat include: estuarine sand, exposed shallow reef and upper slope. The same habitat is considered distinct among bioregions (e.g. "estuarine sand" in North Eastern Bioregion is considered to be distinct from "estuarine sand" in the Southern South Island or any other bioregion).

Marine protected area networks

In this report, a marine protected area (MPA) is a marine reserve or a type 2 MPA. Type 2 MPAs are any spatial management tools that meet the domestic minimum protection standard (see below). All marine reserves are managed by the Department of Conservation. Type 2 MPAs are managed by various authorities (Table 7).

An MPA is a spatial management tool defined by the International Union for Conservation of Nature (IUCN) as 'a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values' (IUCN-WCPA, 2008, UNEP-WCMC, 2008). Under New Zealand's MPA Policy (Department of Conservation and Ministry of Fisheries, 2005), an MPA is defined as 'An area of the marine environment especially dedicated to, or achieving, through adequate protection, the maintenance and/or recovery of biological diversity at the habitat and ecosystem level in a healthy functioning state'.

A network of MPAs is defined as 'a collection of individual MPAs or reserves operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels that are designed to meet objectives that a single reserve cannot achieve' (IUCN-WCPA, 2008, UNEP-WCMC, 2008).

Networks represent different habitats and ecosystems in one or more protected areas. MPA networks provide for the conservation and protection of marine biodiversity and have other associated or incidental benefits (Willis, 2013, UNEP-WCMC, 2008, Roberts and Hawkins, 2000).

Representativity

Representativity is an MPA network design principle that ensures the full suite of habitat types in a bioregion are protected.

Replication

Replication is an MPA network design principle where each habitat is present in at least two MPAs. The replication of habitats in MPAs increases the probability that some habitats will survive and can support the recovery of affected areas in the face of ongoing perturbation.

2.2 MPA policy

As a party to the international Convention on Biological Diversity, New Zealand has committed to work towards achieving the convention's strategic plan for biodiversity, including the five global goals and related Aichi Biodiversity Targets[1] (Secretariat of the Convention on Biological Diversity, 2011).

These international commitments are reflected in New Zealand's Biodiversity Action Plan 2016–2020 (Department of Conservation, 2016) which states that New Zealand will work towards 'a growing nationwide network of marine protected areas, representing more of New Zealand's marine ecosystems' (national target 13).

Currently MPA planning in New Zealand is directed by the Marine Protected Areas Policy and Implementation Plan (Department of Conservation and Ministry of Fisheries, 2005) which has an objective to 'protect marine biodiversity by establishing a network of MPAs that is comprehensive and representative of New Zealand's marine habitats and ecosystems'. It applies to New Zealand's territorial sea (12 nautical miles from the coast) and exclusive economic zone (EEZ). An accompanying document was produced in 2008 (Ministry of Fisheries and Department of Conservation, 2008) to provide guidance on how MPAs would be established, including aspects such as habitat classification, collaborative stakeholder processes, a protection standard (that must be met for the area to be considered part of New Zealand's MPA network) and the activities that require management to meet the protection standard.

2.3 MPA protection standard

The 2005 MPA policy defined a protection standard that had to be met in order for an area to be considered an MPA. The guidance document (Ministry of Fisheries and Department of Conservation, 2008) further defined the protection standard and included guidance on the types of impacts that would preclude an area from recognition as an MPA for the purposes of domestic MPA planning and reporting.

For an area to be an MPA, the management regime needs to provide for the maintenance and recovery of:

- Physical features and biogenic structures that support biodiversity.
- Ecological systems, natural species composition (including all life-history stages), and trophic linkages.
- Potential for the biodiversity to adapt and recover in response to perturbation.

It was considered that if the first two of these were satisfied, then the third would be automatically provided for.

Two types of MPAs were considered to meet the protection standard, based on the fishing methods that the tools managed:

- type 1 MPAs: marine reserves established under the Marine Reserves Act 1971

[1] The Aichi targets include designation of marine protection areas in Target 11: By 2020[…] 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

- type 2 MPAs: MPAs where restrictions made under other legislation offered protection that met the protection standard (e.g. prohibitions on fishing methods[2] under the Fisheries Act 1996 and prohibitions on fishing in the vicinity of submarine cables and pipelines).

In this report, the term MPA is used to refer to type 1 and type 2 marine protected areas.

2.4 Habitat classification

Coastal Classification and Mapping Scheme

The New Zealand Coastal Classification and Mapping Scheme (CCMS, Ministry of Fisheries and Department of Conservation, 2008) is used to approximate spatial patterns in marine biodiversity where more detailed biological information is unavailable. This hierarchical classification identifies habitats within the 14 marine bioregions using a combination of depth, substrate and exposure in estuarine and marine environments.

The CCMS covers estuarine and marine ecosystems in the New Zealand territorial sea up to 200 m deep. Areas in the territorial sea deeper than 200 m can be described using three additional habitat types: upper, mid and lower continental slope. The CCMS does not consider pelagic habitats.

In the CCMS, a total of 44 distinct habitat types were defined based on the combination of depth, substrate and exposure, which multiplies to a potential 616 broad-scale habitats in the 14 bioregions (although not all habitat types will occur in all bioregions). It is assumed that: (1) the biodiversity associated with each habitat is distinct from the biodiversity associated with other habitats, and from the same habitat in other bioregions and (2) the biodiversity associated with each habitat is the same across a bioregion.

Classification of deepwater habitats

The MPA classification, protection standard and implementation guidelines (Ministry of Fisheries and Department of Conservation, 2008) contain guidance for a habitat classification system that could be used for deepwater habitats in New Zealand's exclusive economic zone (EEZ), including benthic and pelagic habitats.

The establishment of benthic protection areas in 2007 used the Marine Environment Classification (MEC) (Snelder et al., 2005) in the design phase (Helson et al., 2010), but no protected areas have been established in the EEZ since then. Several updates and revisions to the MEC have been made (e.g. Leathwick et al., 2012) but there is currently no agreed habitat classification system for use in MPA planning in the EEZ.

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[2] Bottom trawling, dredging and Danish seining were considered to not allow for the maintenance and recovery of physical features and biogenic structures and would not be permitted within a type 2 MPA (in order to meet part (a) of the protection standard). Benthic netting and potting would also be prohibited from a type 2 MPA if they were being used on areas of fragile biogenic habitat. Meeting part (b) of the protection standard requires a case-by-case assessment of the ecological systems and what activities would be inconsistent with their maintenance and recovery. Fishing methods such as midwater trawling, set netting and purse seining were provided as examples of fishing methods that should be assessed.

2.5 MPA inventory and gaps analysis: 2011

A gaps analysis and an inventory were completed in 2011 to assess the progress towards establishing a representative network of MPAs in New Zealand (Department of Conservation and Ministry of Fisheries, 2011).

The analysis assessed the existing protected and managed areas against the protection standard and the CCMS for the New Zealand coastal environment (Ministry of Fisheries and Department of Conservation, 2008). It examined the representativity of MPAs across the full range of habitats and ecosystems in New Zealand's territorial sea.

The 2011 report found that 6.9% of the territorial sea was protected within a type 1 MPA (marine reserve). The area protected was strongly influenced by the large marine reserves in the Kermadec Islands and Subantarctic Islands bioregions. In other bioregions, the proportion of the total area of the territorial sea protected by a marine reserve ranged between 0 and 1%.

A total of 1.14% of the territorial sea met the protection standard for type 2 MPAs. These areas included some sections of the Fiordland (Te Moana o Atawhenua) Marine Area, some cable and pipeline zones, some marine parks, some fisheries closures and one mātaitai reserve. The report concluded that with the exception of the Kermadec Islands bioregion, there were many large omissions in the representativity of all habitats in an MPA.

3 Methods

This report provides an analysis of the gaps in New Zealand's MPA network as at June 2019. It assesses the representativity of habitats as defined by the CCMS, and provides an overview of the science needed to better understand the concept of representativity (as it applies to establishing protected areas and reporting on progress towards an MPA network). This report is also intended to inform discussions about future processes to establish MPAs that ensure a representative network of MPAs in New Zealand, while noting that other factors (e.g. replication) also need to be considered.

3.1 Mapping the habitat classification

Not all of the potential 616 habitats occurred in all bioregions and a total of 416 habitats were mapped for this gaps analysis. Where information to separate different types of biogenic (habitat-creating) reef habitat (e.g. seagrass, bryozoans, mussels) was available, these additional habitats are assessed. The North Eastern bioregion for example, includes 51 habitats. Where estuarine habitats could not be separated into more defined habitats (e.g. estuarine sand and estuarine mud) they were simply mapped as estuarine.

As per the 2011 gaps analysis report, this report maps the surrogates for habitat such as depth, substrate, exposure and the actions of biogenic (habitat forming) organisms. It does not aim to assess outstanding, rare, distinctive, internationally or nationally important habitats or ecosystems, or finer-scale species associations and ecosystem processes. (These important aspects do, however, need to be considered and incorporated into future MPA planning processes.)

The CCMS was applied at a national scale to assess and identify gaps in the representativity and replication of habitats in protected areas. Current MPAs in the territorial sea that meet

the protection standard were overlaid on the CCMS map using GIS, and the proportion of each habitat in an MPA was calculated. The replication of habitats in each bioregion was also assessed (see below).

3.2 Mapping existing MPAs

Protected areas that meet the MPA protection standard (Ministry of Fisheries and Department of Conservation, 2008) and are included in DOC and MPI's Marine Protected Areas: Tier 1 statistic,[3] were included in the mapping. The protected areas in New Zealand's territorial sea were identified and the levels of broad-scale habitat representativity and replication were assessed.

The marine reserves and type 2 MPAs were mapped using spatial data held in DOC's geospatial database.

A preliminary inventory of other protected or managed areas was also made. These areas may provide some protection to marine species or habitats in the territorial sea, and some overlay MPAs. Such areas include:

- Areas of public conservation land that intersect with mean high water springs (as terrestrial protected areas may complement protection measures in the coastal and marine environment).
- Benthic protection areas (BPAs).
- Government purpose reserves[4] and wildlife sanctuaries located within 15 km[5] of the coastal and marine area (as they may provide some protection to marine species and habitats).
- Marine mammal sanctuaries.

New Zealand's EEZ was not considered in the analysis.

3.3 Habitat representativity

Habitat representativity was assessed in marine reserves and type 2 MPAs. Marine mammal sanctuaries and the protected areas listed above were not analysed, as the protection they offer to habitats (as opposed to species) needs to be considered further.

The percentage coverage of each habitat type was calculated in each bioregion individually. For protected areas in the territorial sea, the bioregions as defined by the CCMS and shown in Figure 1 were used (Ministry of Fisheries and Department of Conservation, 2008).

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[3] https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/marine-protected-areas/marine-protected-areas-tier-1-statistic/

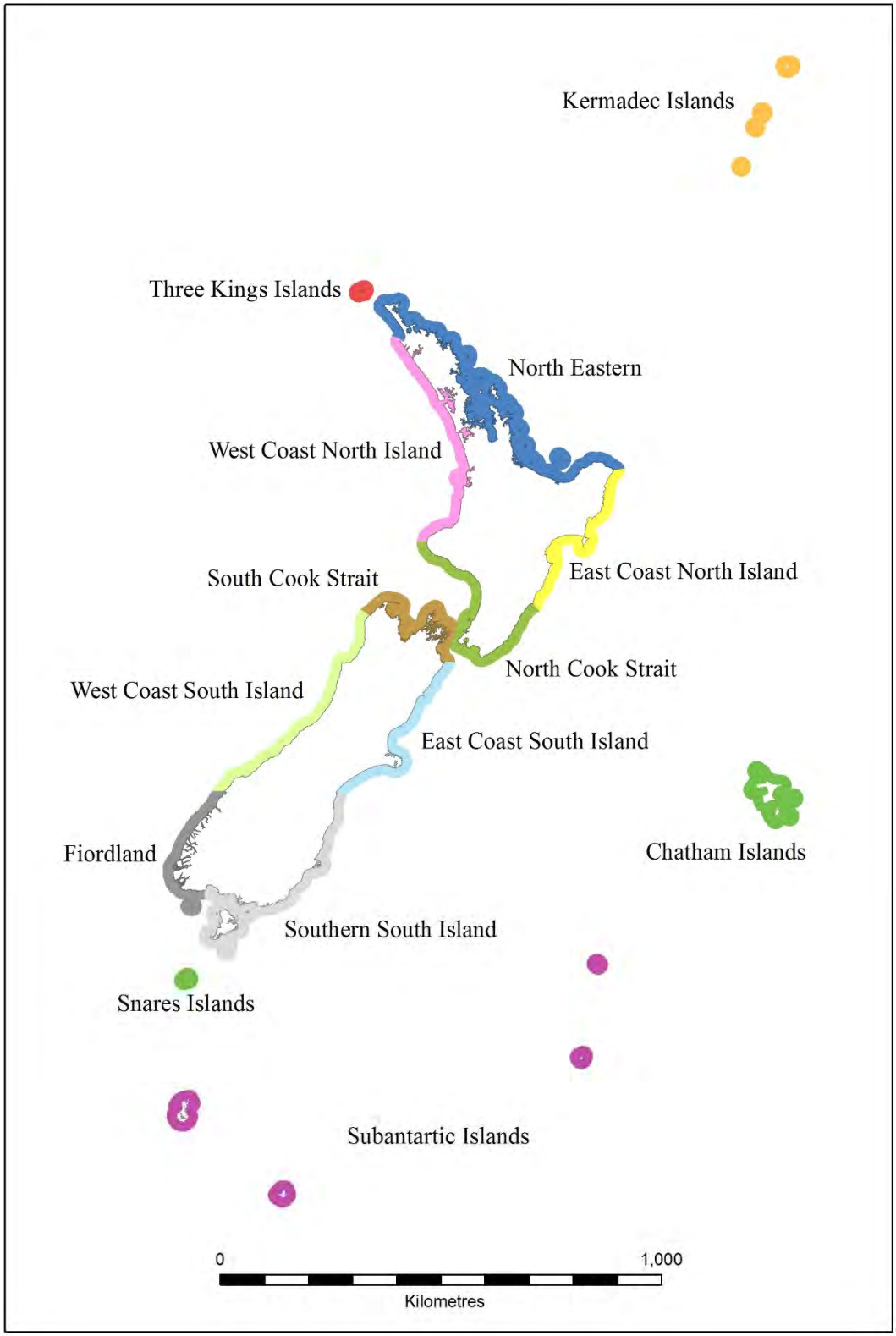
[4] Government Purpose Reserves are class of reserve provided for in s.22 of the Reserves Act

[5] 15km was selected arbitrarily, but was intended to capture at least a subset of terrestrial protected areas that may provide for protection of marine species and habitats. Further analysis would be required to assess adequacy of protection (e.g. through review of management plans and reviewing gazette notices)

Information about the proportion of habitat required to be in an MPA to make it representative is lacking. This report therefore simply states the occurrence of habitats within MPAs and the spatial extent of a habitat in a bioregion that is in an MPA.

Without being able to determine if a type of habitat meets a representativity threshold within an MPA, it is difficult to report on replication between MPAs. Therefore, we report the number of MPAs in a bioregion within which a particular habitat occurs. (Note that the occurrence of a habitat in an MPA, and the number of MPAs where a habitat occurs, are likely to be over-estimates of representativity and replication.)

Figure 1. New Zealand's 14 bioregions, according to the current coastal marine classification (Ministry of Fisheries and Department of Conservation, 2008).



3.4 GIS analyses

The analyses were carried out in two parts. First, ArcGIS 10.3.1 was used to prepare the output data, followed by a calculation of the area of habitat representativity using Microsoft Excel.

Three main datasets were used: the habitats mapped for the 2011 MPA gaps analysis and inventory, marine reserve locations and type 2 MPA locations. Recent revisions of habitats in the Hauraki Gulf and Southeast Otago regions were not incorporated. All datasets had a projection of NZGD2000 (type 2 MPAs were reprojected from WGS84).

Data outputs for MPAs within bioregions and for habitat representativity were produced using the 'intersect' tool within ArcGIS. This created an output that contained the overlapping portions of the input features i.e. the overlap between habitats, bioregions and MPAs. The following were recorded for each habitat within each bioregion: presence or absence (in marine reserves and type 2 MPAs) and whether the area was under a threshold. An arbitrary threshold of 1% was set for spatial extent in an MPA.

Because the bioregions habitat dataset contained multiple polygons of the same habitat, a new output was generated using the 'dissolve' tool. This tool aggregates features based on specific attributes. The dissolve action was based on the 'bioregion' (name) and 'HAB_LEG' (habitat description) fields, which reduced the output to one habitat of each type for each bioregion. The dissolved output was then split into separate datasets for each bioregion.

The figures from these datasets were transferred to Excel to calculate the percentage of habitat represented in an MPA.

There is a discrepancy in the Kermadec Islands bioregion as the gazetted marine reserve is larger than the mapped habitat classification. The Kermadec–L'esperance Rock, Kermadec–Macauley Island, Curtis and Cheeseman Islands and Kermadec–Raoul Island components of the Kermadec Islands bioregion have a combined total area of 6806.003 km^2, while the Kermadec Islands Marine Reserve covers 7126.64 km^2. For the purpose of this analysis, coverage of this bioregion in a marine reserve was assumed to be 100%.

3.5 Habitat replication

Replicating habitats in different MPAs provides a safeguard against a local environmental disaster that would significantly impact populations and habitats in an individual or small MPA. Replication also provides 'stepping stones' for the dispersal of marine species.

Habitat replication (the number of times habitats are represented in MPAs) was analysed as this is an important component of MPA network design (IUCN-WCPA, 2008, Lundquist et al., 2015, Conference of the Parties to the Convention on Biological Diversity, 2008). Replication within a bioregion was calculated as the number of times each habitat occurred within marine reserves or MPAs within the bioregion boundaries. Because the interaction of replication with adequacy of protection is complex, for the purposes of this analysis, only the presence or absence of a habitat (rather than the percentage of habitat replicated) was used to assess replication.

3.6 Limitations of the gaps analysis

This analysis does not account for any biodiversity outside MPAs that may act as a source of recruits or add to the connectivity of habitats in an MPA network.

The analysis also assumes that only marine reserves and type 2 MPAs contribute to the network, although other protection measures operate in some New Zealand coastal and marine environments. (Such measures could be assessed for their contribution to an MPA network and the conservation benefits they offer to species and habitats.)

This analysis is based on the presence or absence of habitats in an MPA and on their spatial extent. It does not consider aspects such as its condition or its patchiness. (The quality of habitat and the adequacy of coverage require further consideration as part of an assessment of how a representative network of MPAs in New Zealand can be achieved.)

The representativity of habitats assessed here is only one component of MPA network design. Other aspects include protecting ecologically important habitats, providing for connectivity and considering the adequacy of protection. (See also New Zealand marine protected areas: Principles for network design. DOC, MfE, MPI 2018 in prep.).

There are some known issues with the current CCMS, including its inadequacy as a surrogate for biological diversity in some areas, particularly at finer scales. The scheme also has inaccuracies at regional and local scales that need to be taken into account in any MPA or spatial planning process. Revision of the CCMS is being considered.

The information provided here should not be used in MPA planning processes in isolation as it does not reflect the full suite of ecological, cultural, economic and social considerations that should be part of a robust MPA network design process.

4 Results

4.1 Marine protected area coverage

Apart from the Kermadec and Subantarctic Islands bioregions (which are fully encompassed in MPAs), all bioregions were found to have significant gaps in their habitat representativity and replication in MPAs. Even in bioregions where there are several MPAs, the coverage and replication of habitats has been achieved to varying extents.

Forty-four marine reserves and 19 type 2 MPAs cover 12.3% of New Zealand's territorial sea (9.8% in marine reserves and 2.6% in type 2 MPAs). Of the 9.8% coverage in marine reserves, 9.4% is around outlying island groups (Kermadec, Three Kings, Snares, Chatham and Subantarctic Islands) and 0.4% is around the mainland coast.

Almost half (48.1%) of the territorial sea around outlying island groups is in a marine reserve. Two bioregions (Kermadec Islands and Subantarctic Islands) are fully encompassed in MPAs but three bioregions (Snares, Three Kings and Chatham Islands) have no MPAs.

Mainland bioregions have 0.3–4.7% of their area in an MPA.

4.2 Representativity

The representativity of habitats in an MPA varied. Of the 416 habitats identified across the 14 bioregions:

- more than 65% are not in a marine reserve
- 79% have less than 1% of their extent in a marine reserve
- 70% have less than 1% of their overall extent in an MPA
- 68% of habitats in mainland bioregions have no representativity in a marine reserve.

At least half of the habitats in 5 out of 9 mainland bioregions have some representation in an MPA, while less than half of the habitats in the remaining 4 mainland bioregions are represented in an MPA. For mainland bioregions, between 17% (East Coast South Island) and 42% (North Cook Strait) of the habitats have at least 1% of that habitat's regional extent within an MPA.

Between 11% (Southern South Island) and 32% (West Coast South Island) of the habitats in mainland bioregions have at least 1% of their extent within a marine reserve.

4.3 Replication

The levels of habitat replication in MPAs are generally low, with several bioregions having no replication. Replication in marine reserves is lower than in MPAs, with only four bioregions (Fiordland, North Eastern, West Coast South Island and Subantarctic Islands) having some habitats replicated in more than two marine reserves. For the Kermadec Bioregion, the whole bioregion is encompassed in a marine reserves so it was not possible nor necessary to assess replication.

The assessment of replication does not account for the adequacy of protection provided by the MPA.

4.4 Overview of MPAs

Table 1 shows the protection tools mapped as part of this analysis. As at June 2019, New Zealand has a total of 44 marine reserves (Figure 2, Table 6 in Appendix 1) and 19 type 2 MPAs (Figure 3, Table 7 in Appendix 2) that meet the New Zealand MPA protection standard.

The mapped MPAs range from the subtropical Kermadec Islands to the subantarctic Campbell Island/Moutere Ihupuku Marine Reserve. The Kermadec Islands Marine Reserve is New Zealand's largest marine reserve, with an area of more than 7,000 km2; the smallest is Tauparikaka Marine Reserve (South Island West Coast) at approximately 0.16 km2. New Zealand's first MPA was established at Leigh in 1975 (Cape Rodney–Okakari Point Marine Reserve) and the most recent MPAs were established on the South Island's west coast in 2015 – three new type 2 MPAs under the Fisheries Act regulations.

Table 1. Overview of New Zealand's MPAs in the territorial sea as at June 2019.

Marine protection tool	Designation	Number	Extent (km²)
Mainland New Zealand			
Type 1 MPAs	Marine reserves	39	615
Type 2 MPAs	Fisheries closures	5	120.9
	Fiordland Marine Area	1	380.3
	Te Whaka a Te Wera Mātaitai	1	77.6
	Cable protection zones	8	1,578.9
	Sugar Loaf Islands MPA	1	4.2
	Mimiwhangata Marine Park	1	18.5
Outlying islands			
Type 1 MPAs	Marine reserves	5	17,083
Type 2 MPAs	Fisheries closures	2	2,516.2
Total			
Type 1 MPAs		44	17,697
Type 2 MPAs		19	4,693.5

4.5 Other spatial protection tools

Several BPAs in New Zealand's territorial sea (Figure 17) overlap with marine reserves:

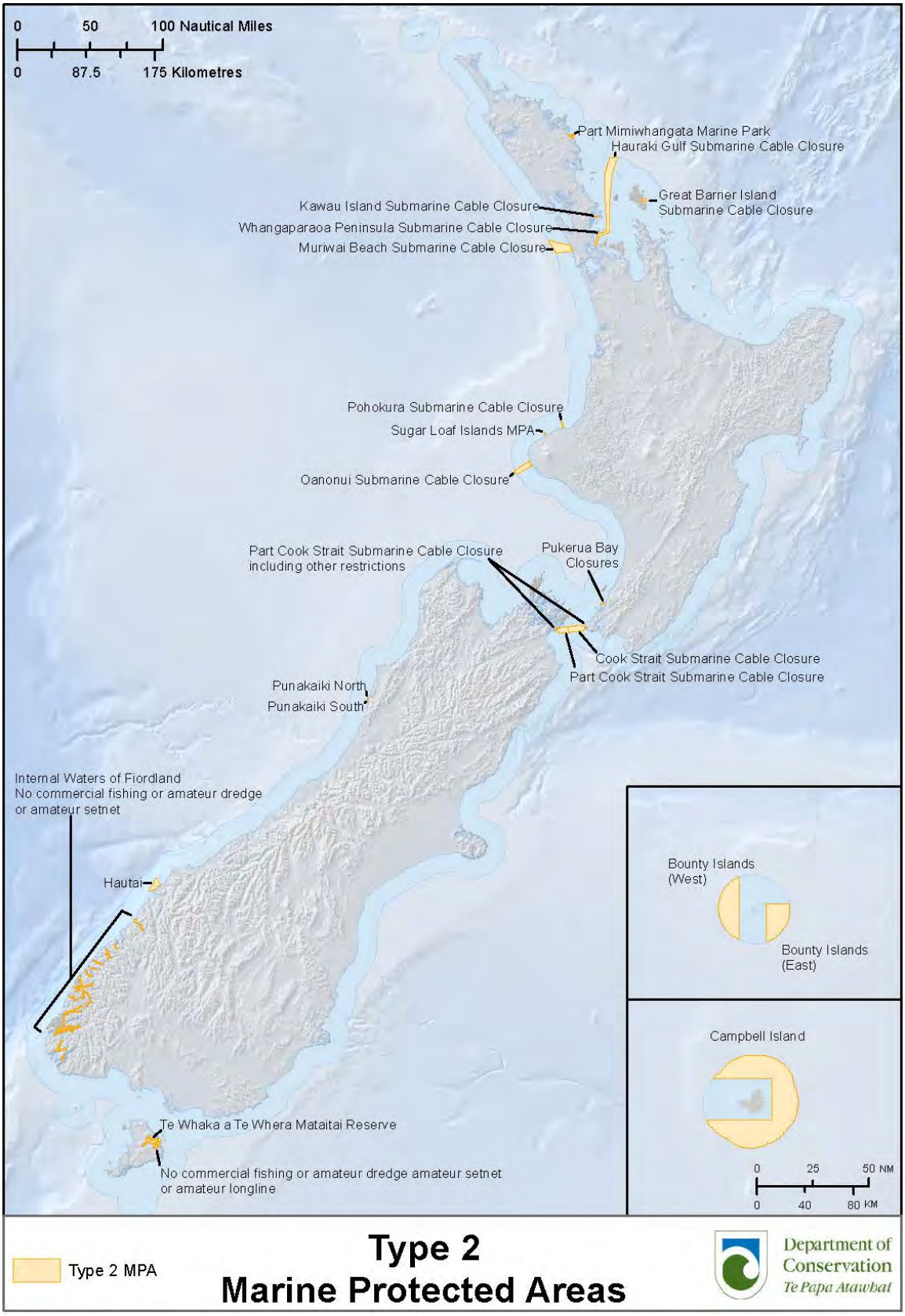
- Kermadec BPA overlaps Kermadec Islands Marine Reserve
- Antipodes Transect BPA overlaps Antipodes Island/Moutere Mahue Marine Reserve
- Bounty Heritage BPA partially overlaps Bounty Islands/Moutere Hauriri Marine Reserve – the remainder of the BPA has restrictions on fishing to meet the MPA protection standard (this area is a type 2 MPA)
- Campbell Heritage BPA partially overlaps Campbell Island/Moutere Ihupuku Marine Reserve – the remainder of the BPA has restrictions on fishing to meet the MPA protection standard (this area is also a type 2 MPA).

A total of 1171 areas of public conservation land were found to intersect mean high water springs. These areas included: recreation reserves, historic reserves, scenic reserves, conservation parks, nature reserves, ecological areas, scientific reserves, government purpose reserves, sanctuary areas, local purpose reserves, fixed marginal strips, stewardship areas and national parks.

There are eight marine mammal sanctuaries in the territorial sea (Figure 18), and 13 wildlife sanctuaries and 123 government purpose reserves are located within about 15 km of the coast (Figure 19, Figure 20). Further analysis is required to assess the protection they provide to coastal and marine species and habitats.

Figure 2. Map of New Zealand's 44 marine reserves as at June 2019.

Figure 3. Map of New Zealand's 19 type 2 MPAs as at June 2019.



4.6 Overview of bioregions

Table 2 and Figure 4 provide an overview of the established marine protection in each bioregion. In the nine mainland bioregions, variable coverage of coastal and marine habitats is provided by marine reserves or a combination of marine reserves and type 2 MPAs.

On average, 0.4% of each mainland bioregion is protected in a marine reserve, ranging from 0.1% (Southern South Island) to 1.3% (West Coast South Island). An average of 1.9% of each mainland bioregion is contained within an MPA, ranging from 0.3% in the Eastern North Island bioregion to 4.7% in Fiordland.

For the outlying islands bioregions, one coastal bioregion (Kermadec) is fully encompassed in a marine reserve. A second bioregion (Subantarctic Islands) is fully encompassed in marine reserves and type 2 MPAs. Three bioregions (Three Kings, Chatham Islands and Snares Islands) have no marine reserves or type 2 MPAs present.

The extent of representation and replication varies across bioregions. Some bioregions have similar levels of habitat representativity but their level of replication varies considerably. For example, 61% of habitats within the North Eastern bioregion are present in 15 MPAs, whereas the North Cook Strait bioregion has a similar percent of habitats present in just three MPAs. As a result, the North Eastern bioregion has a higher level of habitat replication than North Cook Strait for roughly the same proportion of protected area.

Figure 4. Percentage of each bioregion in a marine reserve or type 2 MPA.

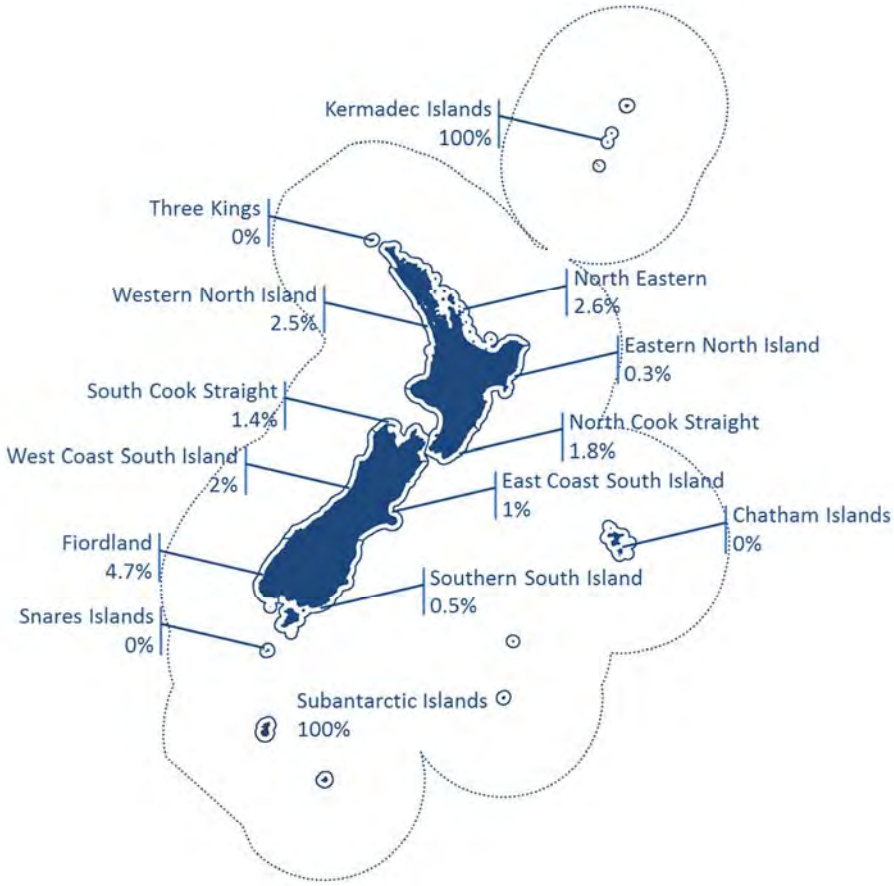


Table 2. Summary of marine protection for each bioregion.

Coastal bioregion	Number of marine reserves	Number of type 2 MPAs	Percentage of bioregion		
			in a marine reserve	in a type 2 MPA	in an MPA
Mainland New Zealand					
Western North Island	2	3	0.22%	2.24%	2.46%
North Cook Strait	2	3*	0.06%	1.76%	1.83%
Eastern North Island	2	0	0.25%	0%	0.25%
North Eastern	10	5	0.22%	2.36%	2.58%
South Cook Strait	4	1*	0.31%	1.13%	1.44%
West Coast South Island	5	3	1.31%	0.73%	2.03%
Fiordland	10	1	1.01%	3.71%	4.72%
Southern South Island	1	2	0.05%	0.42%	0.47%
East Coast South Island	3	0	1.0%	0%	1.0%
Total for mainland	**39**	**17***			
Average in mainland bioregions			**0.4%**	**1.5%**	**1.9%**
Outlying islands					
Kermadec Islands	1	0	100%	0%	100%
Three Kings	0	0	0%	0%	0%
Snares Islands	0	0	0%	0%	0%
Subantarctic Islands	4	2	79.3%	21.2%	100%
Chatham Islands	0	0	0%	0%	0%
Total for outlying island bioregions	***5***	***2***			
Average in outlying island bioregions			**48.1%**	**7.1%**	**55.2%**
Total number of MPAs	**44**	**19***			
Percentage of territorial sea in an MPA			**9.8%**	**2.6%**	**12.3%**

* The Cook Strait Submarine Cable Closure is in both North and South Cook Strait bioregions.

Habitat representativity

For mainland bioregions, an average of 46% of the habitats in each bioregion were present in at least one MPA (Table 3). The proportion of habitats in a marine reserve ranged from 18% (Western North Island) to 43% (North Eastern) while 26% (Western North Island) to 61% (North Eastern) were in either a marine reserve or a type 2 MPA (Figure 5).

For five of the nine mainland bioregions, half or more of the habitats occurring in the bioregion were present in an MPA (Table 3). (Note: this is reported simply as the presence or absence of a habitat, rather than a viable example of that habitat.) Most bioregions have many habitats that are not present in either a marine reserve or a type 2 MPA. Also, many of the habitats that are in MPAs have less than 1% of their extent in an MPA (Table 5).

Of the 348 habitats assessed as being present in mainland bioregions, 189 (54%) were not in an MPA (Table 5), 252 habitats (72%) had coverage of less than 1% in an MPA and 33 habitats (9.5%) had coverage of greater than 10% in an MPA. Two hundred and thirty-five habitats (68%) were not represented in any marine reserve and 292 habitats (84%) had coverage of less than 1% in a marine reserve.

Habitat replication in MPAs

The replication of habitats in marine reserves (i.e. the percentage of habitats in a bioregion that are present in more than one marine reserve) ranged from 0% (Southern South Island) to 32% (West Coast South Island) (Table 3). Only three mainland bioregions had habitats that were replicated in more than two marine reserves (North Eastern, West Coast South Island and Fiordland).

Seven mainland bioregions had between 7 and 35% of their habitats replicated in more than two MPAs. Note: this is simply the presence or absence of a habitat, and does not consider the area of habitat protected or whether that habitat is viable.

The scale of protection for outlying islands (if present) makes it highly likely that habitats in an MPA are replicated within an individual MPA. This replication has not been assessed, however, and is not discussed in this report.

Figure 5. Percentage of habitats in each bioregion with some representation in an MPA (>0%), or with more than 1, 5 or 10% representation.

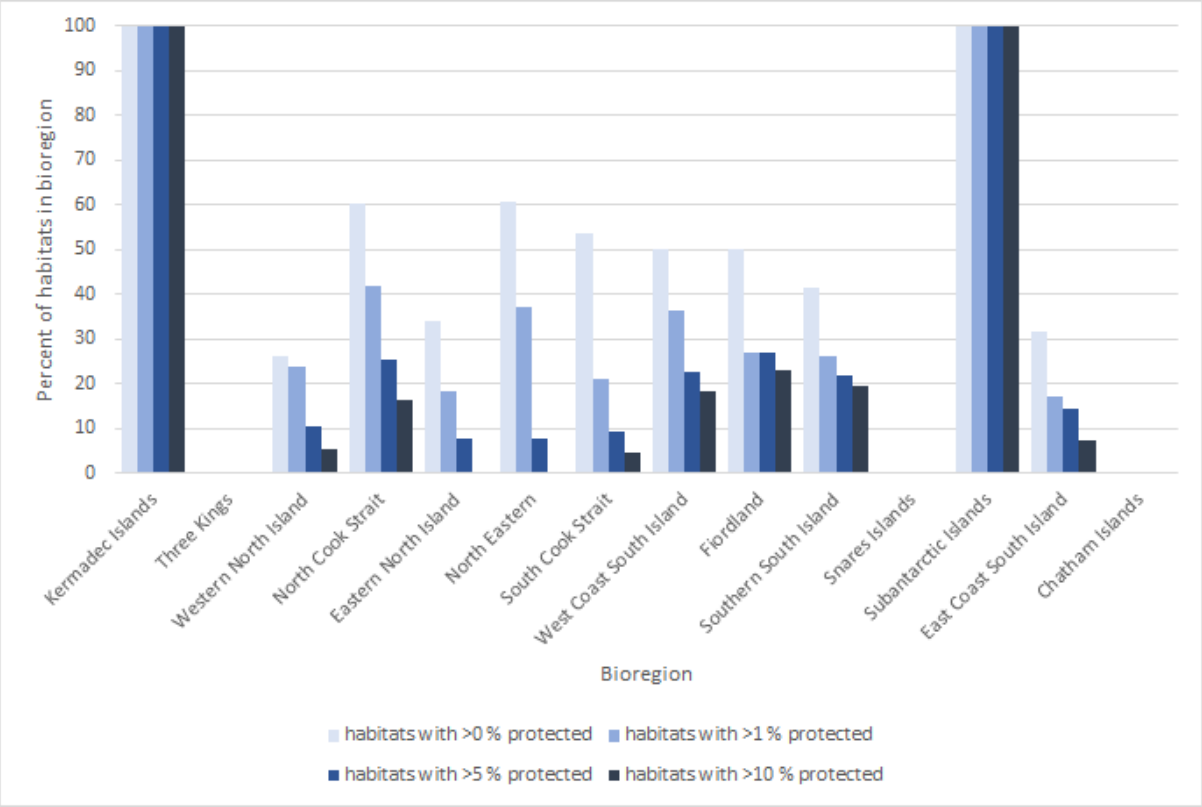
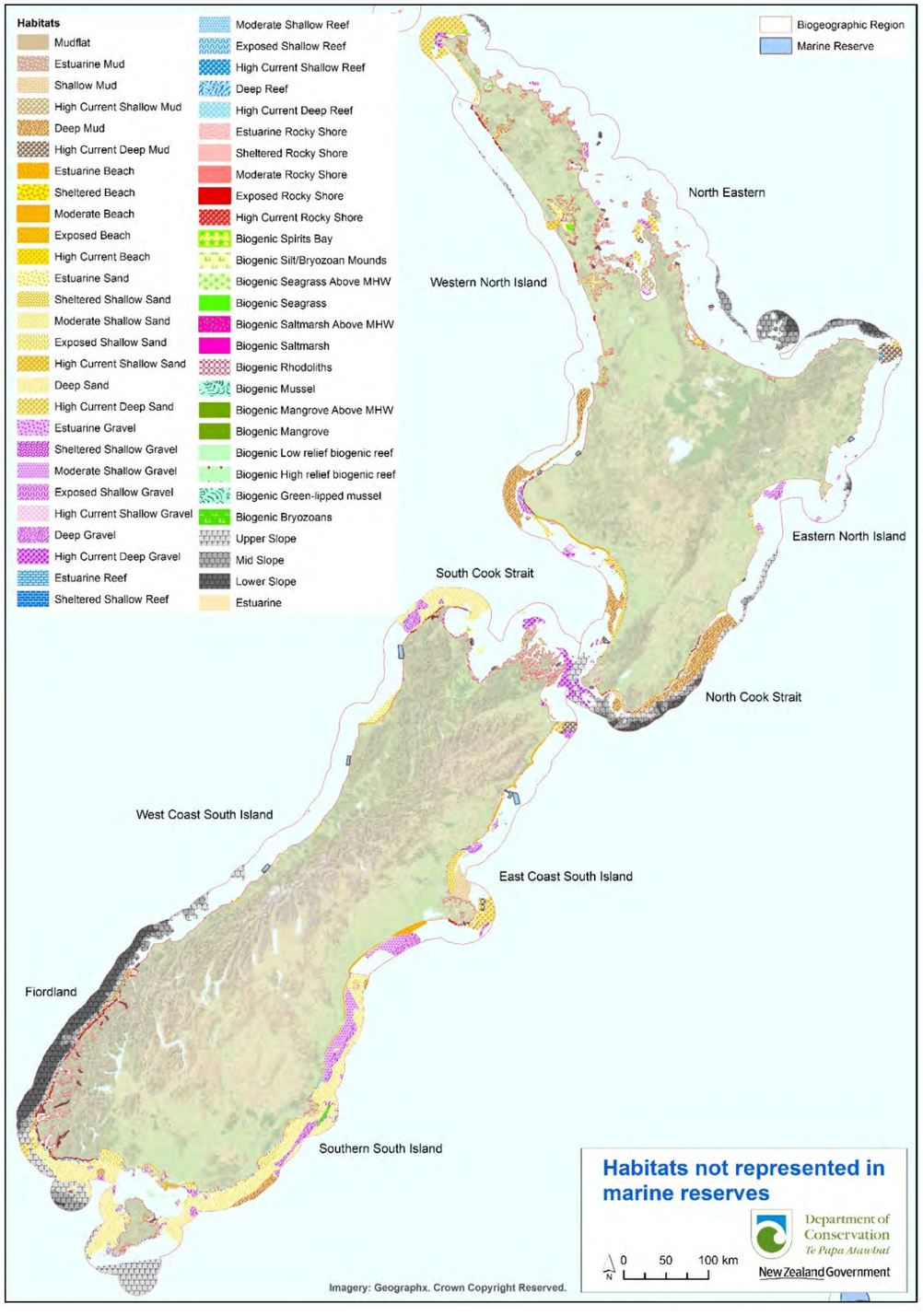


Table 3. Summary of representativity and replication of habitats within MPAs in the 14 bioregions.

Bioregion	Number of habitats	Percentage of habitats					
		in marine reserves	in MPAs	replicated in >1 marine reserve	replicated in >2 marine reserves	replicated in >1 MPA	replicated in >2 MPAs
Mainland New Zealand							
Western North Island	38	18%	26%	8%	0%	16%	13%
North Cook Strait	43	28%	60%	9%	0%	19%	9%
Eastern North Island	38	34%	34%	8%	0%	8%	0%
North Eastern	51	43%	61%	31%	22%	43%	35%
South Cook Strait	43	42%	53%	12%	0%	23%	7%
West Coast South Island	22	41%	50%	32%	18%	41%	27%
Fiordland	26	27%	50%	15%	15%	23%	15%
Southern South Island	46	26%	41%	0%	0%	26%	13%
East Coast South Island	41	32%	32%	12%	0%	12%	0%
All mainland bioregions	**348**	**32%**	**46%**	**14%**	**5%**	**23%**	**13%**
Outlying islands							
Kermadec Islands	11	100%	100%	n/a	n/a	n/a	n/a
Three Kings	8	0%	0%	0%	0%	0%	0%
Snares Islands	10	0%	0%	0%	0%	0%	0%
Subantarctic Islands	20	100%	100%	74%	47%	79%	47%
Chatham Islands	19	0%	0%	0%	0%	0%	0%
Average all bioregions	**416**	**35%**	**46%**	**15%**	**7%**	**23%**	**13%**

Figure 6. Left: habitats in mainland bioregions that are not represented in any marine reserve. Right: habitats that have less than 1% of their spatial extent in a marine reserve.



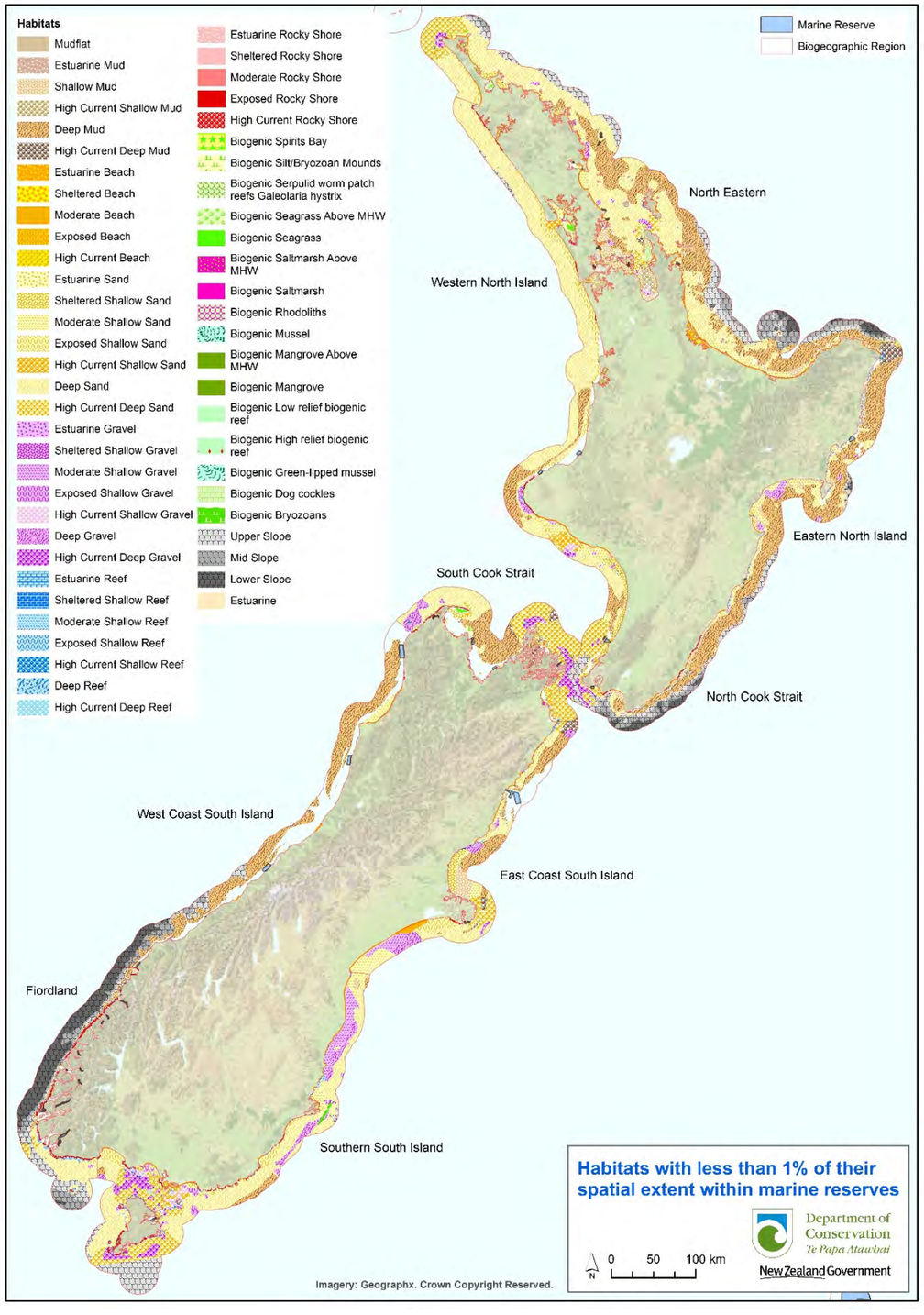
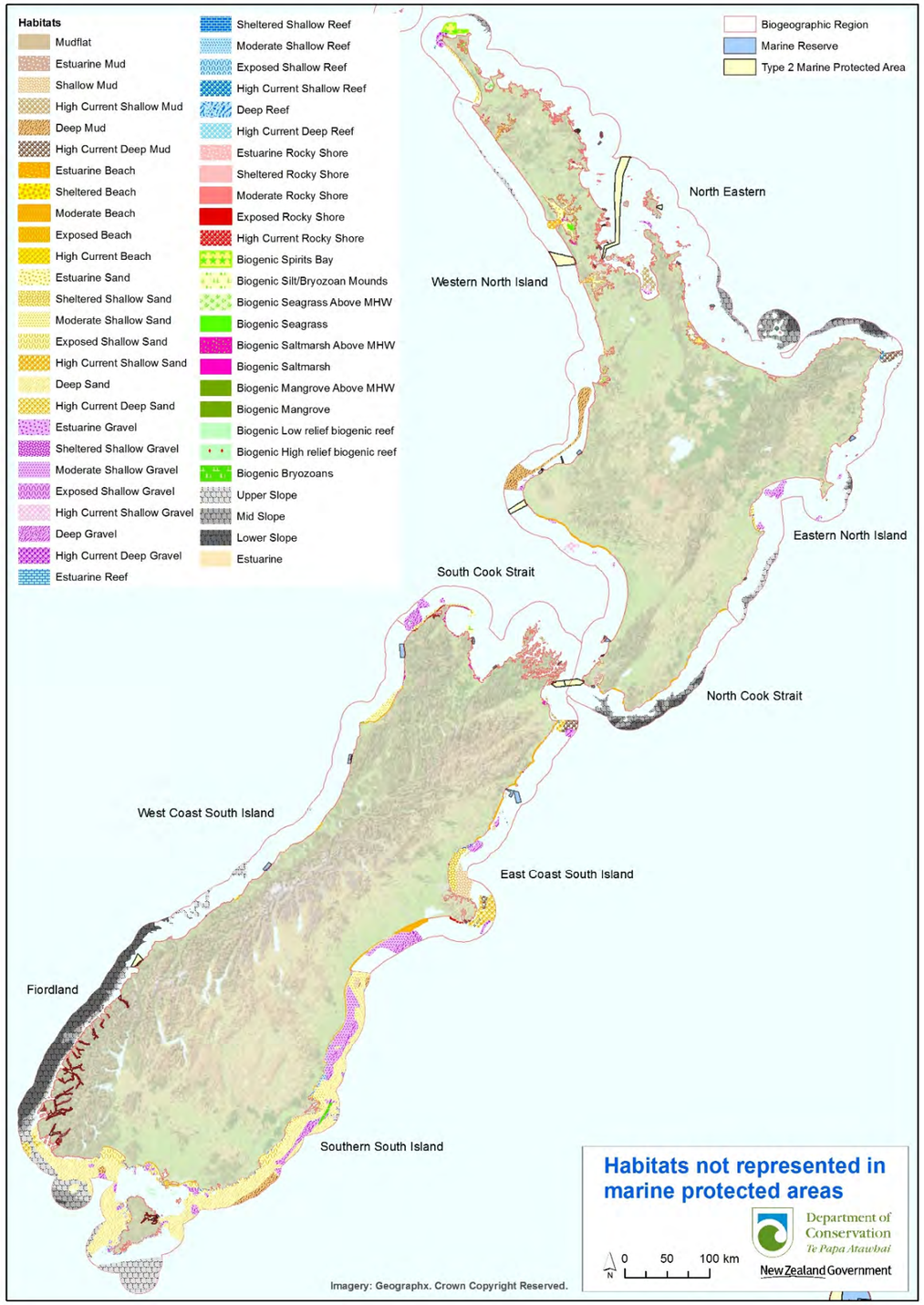


Figure 7. Left: habitats in mainland bioregions that are not present in any MPA (marine reserve or type 2 MPA). Right: habitats that have less than 1% of their spatial extent in an MPA.



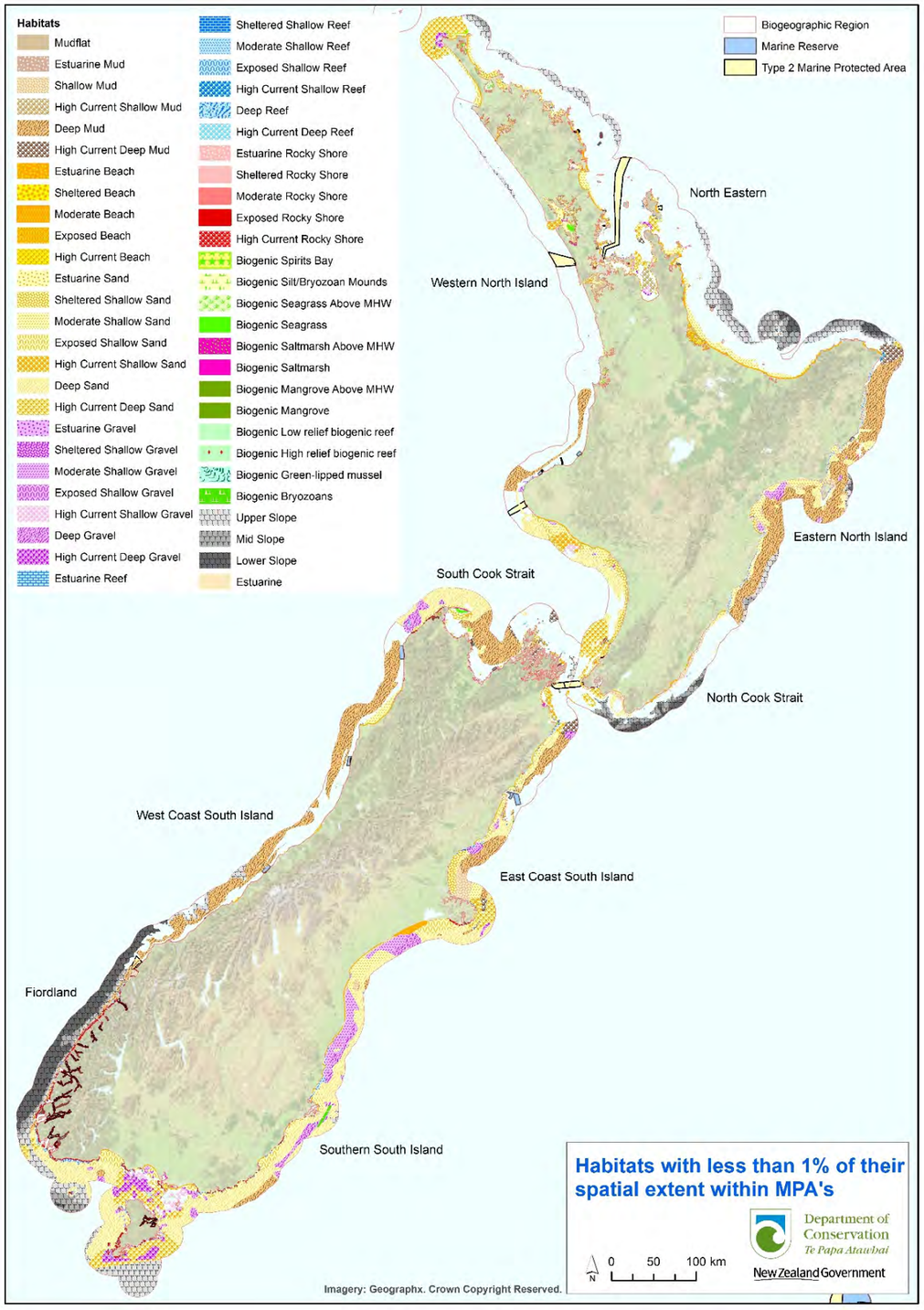


Table 4. Mainland bioregion habitats and the extent of their inclusion in a marine reserve.

Mainland bioregion	Number of habitats	Habitats not in marine reserve	Some of habitat in marine reserve	Percentage of habitat area included in a marine reserve e.g. in Fiordland, 6 habitats have >1% of their extent protected, 5 have >5% protected etc.				
				>1%	>5%	>10%	>20%	>50%
Western North Island	38	31	7	5	2	2	0	0
North Cook Strait	43	31	12	7	2	1	0	0
Eastern North Island	38	25	13	7	3	0	0	0
North Eastern	51	29	22	6	1	0	0	0
South Cook Strait	43	25	18	6	2	0	0	0
West Coast South Island	22	13	9	7	3	0	0	0
Fiordland	26	19	7	6	5	4	1	1
Southern South Island	46	34	12	5	2	1	1	0
East Coast South Island	41	28	13	7	6	3	0	0
Total	**348**	**235 (68%)**	**113 (32%)**	**56 (24%)**	**26 (9%)**	**11 (3%)**	**2 (<1%)**	**1 (<1%)**

Table 5. Mainland bioregion habitats and the extent of their inclusion in an MPA.

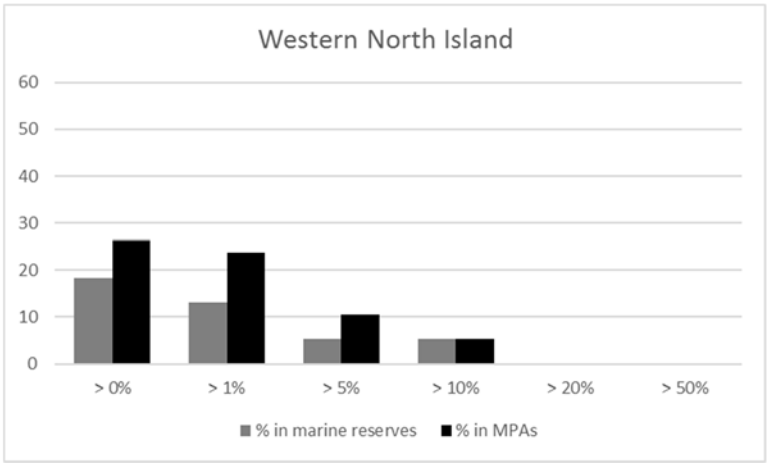
Mainland bioregion	Number of habitats	Habitats not in MPA	Some of habitat in MPA	Percentage of habitat in an MPA				
				>1%	>5%	>10%	>20%	>50%
Western North Island	38	28	10	9	4	2	0	0
North Cook Strait	43	17	26	18	11	7	2	0
Eastern North Island	38	25	13	7	3	0	0	0
North Eastern	51	20	31	19	4	0	0	0
South Cook Strait	43	20	23	9	4	2	0	0
West Coast South Island	22	11	11	8	5	4	1	0
Fiordland	26	13	13	7	7	6	4	1
Southern South Island	46	27	19	12	10	9	8	4
East Coast South Island	41	28	13	7	6	3	0	0
Total	**348**	**189 (54%)**	**159 (46%)**	**96 (28%)**	**54 (16%)**	**33 (9%)**	**15 (4%)**	**5 (1%)**

4.7 Gaps analysis by bioregion: mainland

Western North Island

Marine reserves	2
Type 2 MPAs	3
Extent of bioregion in an MPA	2.5%
Habitats	38
Habitats represented in a marine reserve	7
Habitats with <1% of their extent in a marine reserve	33
Habitats with >10% of their extent in a marine reserve	2
Extent of habitats represented in a marine reserve	0.0009–12.67%
Habitats represented in an MPA	10
Habitats with <1% of their extent in an MPA	29
Habitats with >10% of their extent in an MPA	2
Extent of habitats represented in an MPA	0.00241–15.38%
Habitats not represented in an MPA include	large areas of estuarine and deep mud habitats, smaller areas of biogenic, reef and soft sediment habitats (Table 8)
Replication	3 habitats in more than one marine reserve, 6 habitats in more than one MPA

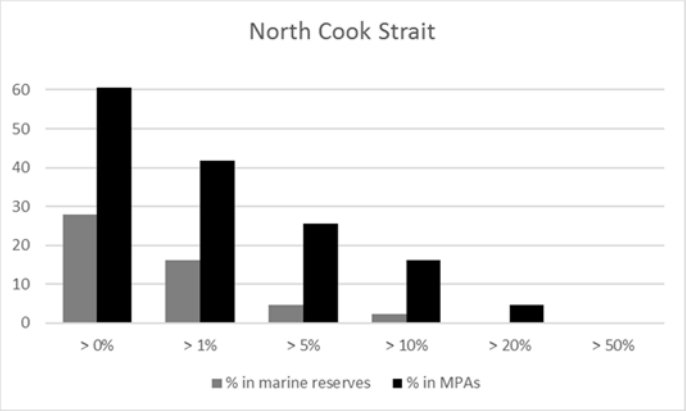
Figure 8. Western North Island bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%



North Cook Strait

Marine reserves	2
Type 2 MPAs	3
Extent of bioregion in an MPA	1.8%
Habitats	43
Habitats represented in a marine reserve	12
Habitats with <1% of their extent in a marine reserve	36
Habitats with >10% of their extent in a marine reserve	1
Extent of habitats represented in a marine reserve	0.06–10.75%
Habitats represented in an MPA	26
Habitats with <1% of their extent in an MPA	25
Habitats with >10% of their extent in an MPA	7
Extent of habitats represented in an MPA	0.018–28.43%
Habitats not represented in an MPA include	biogenic and estuarine habitats and extensive areas of lower and mid-slope habitats off the south coast of the North Island (Table 9)
Replication	4 habitats in 3 different MPAs

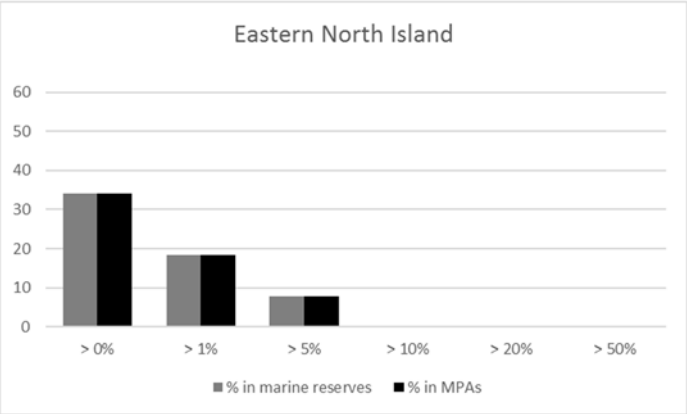
Figure 9. North Cook Strait bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50.



Eastern North Island

Marine reserves	2
Type 2 MPAs	0
Extent of bioregion in an MPA	0.3%
Habitats	38
Habitats represented in a marine reserve	13
Habitats with <1% of their extent in a marine reserve	31
Habitats with >10% of their extent in a marine reserve	0
Extent of habitats represented in a marine reserve	0.0002–8.38%
Habitats represented in an MPA	13
Habitats with <1% of their extent in an MPA	31
Habitats with >10% of their extent in an MPA	0
Extent of habitats represented in an MPA	0.0002–8.38%
Habitats not represented in an MPA include	biogenic and estuarine habitats, areas of high current (in particular off East Cape), sheltered habitats and areas of lower, mid and upper slope, gravel habitat near Napier and north of Cape Kidnappers (Table 10)
Replication	3 habitats in 2 marine reserves

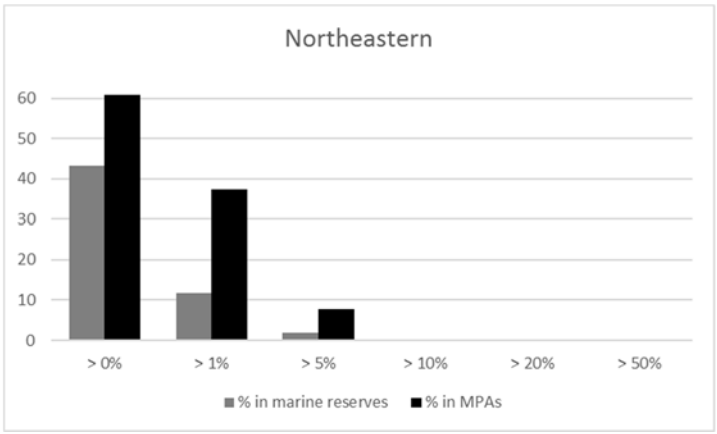
Figure 10. Eastern North Island bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%



North Eastern

Marine reserves	10
Type 2 MPAs	5
Extent of bioregion in an MPA	2.6%
Habitats	51
Habitats represented in a marine reserve	22
Habitats with <1% of their extent in a marine reserve	45
Habitats with >10% of their extent in a marine reserve	0
Extent of habitats represented in a marine reserve	0.025–6.1%
Habitats represented in an MPA	31
Habitats with <1% of their extent in an MPA	32
Habitats with >10% of their extent in an MPA	0
Extent of habitats represented in an MPA	0.02–6.1%
Habitats not represented in an MPA include	large areas around North Cape, Spirits Bay and Ninety Mile Beach, areas of mid and lower slope around the Bay of Plenty's offshore islands and outer edge of the territorial sea, some habitats in the Firth of Thames and Colville Channel (Table 11)
Replication	1 habitat in 9 MPAs, 2 habitats in 8 MPAs

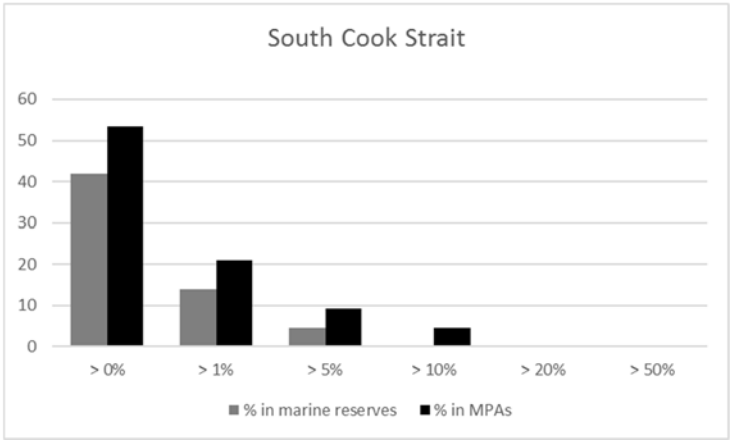
Figure 11. Northeastern bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%



South Cook Strait

Marine reserves	4
Type 2 MPAs	1
Extent of bioregion in an MPA	1.4%
Habitats	43
Habitats represented in a marine reserve	18
Habitats with <1% of their extent in a marine reserve	37
Habitats with >10% of their extent in a marine reserve	0
Extent of habitats represented in a marine reserve	0.007–7.92%
Habitats represented in an MPA	23
Habitats with <1% of their extent in an MPA	34
Habitats with >10% of their extent in an MPA	2
Extent of habitats represented in an MPA	0.01–7.92%
Habitats not represented in an MPA include	large areas of deep gravel, exposed shallow sand and moderately exposed shallow sand off Farewell Spit and the northwest tip of the South Island, biogenic habitats off Separation Point (Table 12)
Replication	Most habitats in marine reserves not replicated in other marine reserves; 8 habitats replicated in Cook Strait Cable Closure

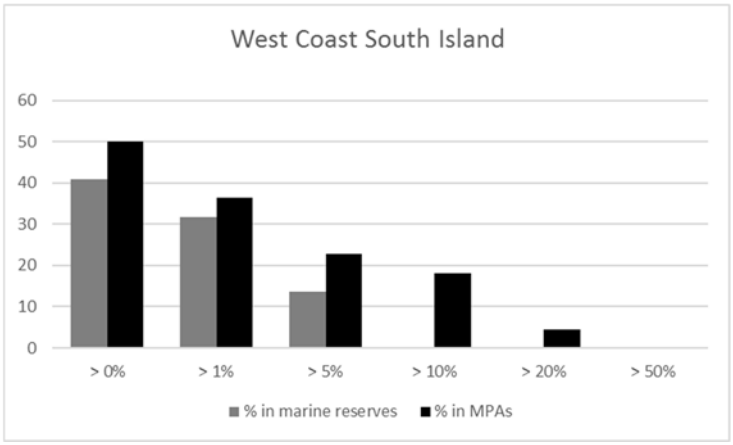
Figure 12. South Cook Strait bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%.



West Coast South Island

Marine reserves	5
Type 2 MPAs	3
Extent of bioregion in an MPA	2%
Habitats[6]	22
Habitats represented in a marine reserve	9
Habitats with <1% of their extent in a marine reserve	15
Habitats with >10% of their extent in a marine reserve	0
Extent of habitats represented in a marine reserve	0.08–7.70%
Habitats represented in an MPA	11
Habitats with <1% of their extent in an MPA	14
Habitats with >10% of their extent in an MPA	4
Extent of habitats represented in an MPA	0.08–7.70%
Habitats not represented in an MPA include	moderate shallow sand habitat north of Cape Foulwind, slope habitats in the south of the bioregion (Table 13)
Replication	6 habitats in at least 3 MPAs, one habitat (exposed beach) in 7 MPAs, one (exposed shallow reef) in 6 MPAs

Figure 13. West Coast South Island bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%.

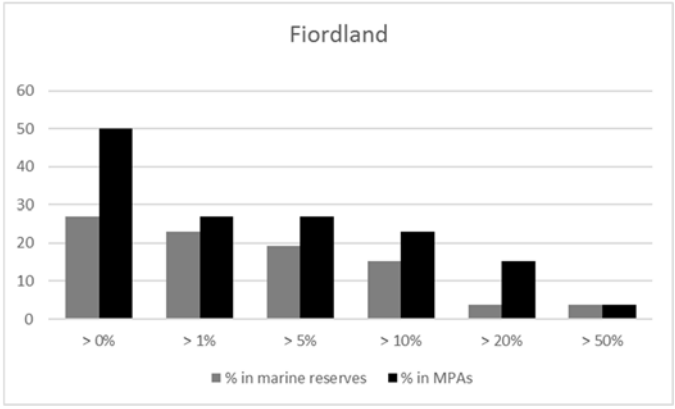


[6] Note that for the purposes of MPA planning in the West Coast South Island bioregion, the forum considered representativity of 17 habitats.

Fiordland

Marine reserves	10
Type 2 MPAs	1
Extent of bioregion in an MPA	4.7%
Habitats	26
Habitats represented in a marine reserve	7
Habitats with <1% of their extent in a marine reserve	20
Habitats with >10% of their extent in a marine reserve	4
Extent of habitats represented in a marine reserve	0.0009–70.48%
Habitats represented in an MPA	13
Habitats with <1% of their extent in an MPA	19
Habitats with >10% of their extent in an MPA	6
Extent of habitats represented in an MPA	0.0009–70.48% (mudflat)
Habitats not represented in an MPA include	offshore slope and deepwater habitats are the largest areas but others include high current and exposed rocky shore and shallow habitats (Table 14)
Replication	Some habitats (e.g. estuarine sand) have more of their extent in MPAs than others, but low levels of replication; other habitats have a similar extent in MPAs but higher levels of replication (11 MPAs in the case of estuarine reef)

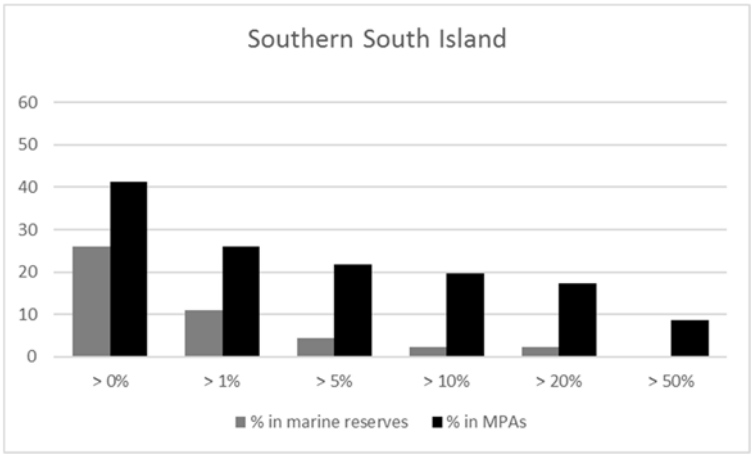
Figure 14. Fiordland bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%.



Southern South Island

Marine reserves	1
Type 2 MPAs	2
Extent of bioregion in an MPA	0.5%
Habitats	46
Habitats represented in a marine reserve	12
Habitats with <1% of their extent in a marine reserve	41
Habitats with >10% of their extent in a marine reserve	1
Extent of habitats represented in a marine reserve	0.0002–22.71%
Habitats represented in an MPA	19
Habitats with <1% of their extent in an MPA	34
Habitats with >10% of their extent in an MPA	9
Extent of habitats represented in an MPA	0.0004–100%
Habitats not represented in an MPA include	deep gravel, deep mud, biogenic bryozoans, exposed shallow gravel, sheltered shallow sand (Table 15)
Replication	11 habitats in the marine reserve are replicated in one or both type 2 MPAs, 1 habitat is replicated in both type 2 MPAs, 6 habitats are in all three MPAs

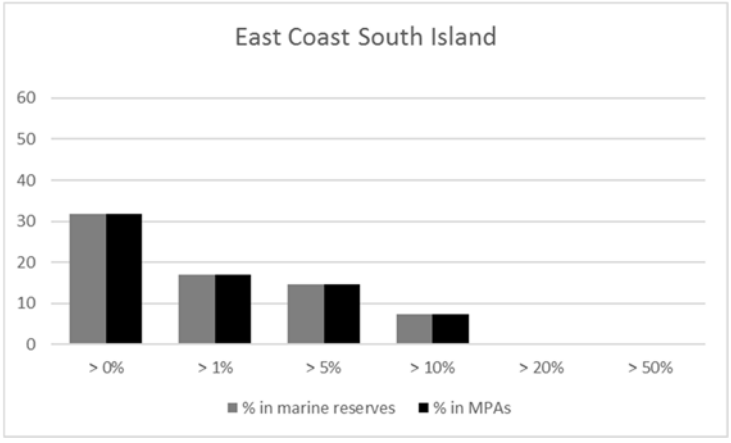
Figure 15. Southern South Island bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type 2 MPAs) at levels between >0% and >50%.



East Coast South Island

Marine reserves	3
Type 2 MPAs	0
Extent of bioregion in an MPA	1%
Habitats	41
Habitats represented in a marine reserve	13
Habitats with <1% of their extent in a marine reserve	34
Habitats with >10% of their extent in a marine reserve	3
Extent of habitats represented in a marine reserve	0.005–11.27%
Habitats represented in an MPA	13
Habitats with <1% of their extent in an MPA	34
Habitats with >10% of their extent in an MPA	3
Extent of habitats represented in an MPA	0.005–11.27%
Habitats not represented in an MPA include	biogenic and estuarine habitats, deep soft sediment habitats (in particular offshore from Banks Peninsula and southwest along the coast from Lake Ellesmere) (Table 16)
Replication	5 habitats in 2 marine reserves

Figure 16. East Coast South Island bioregion: percentage of habitats represented in a marine reserve or MPAs (marine reserves and type2 MPAs) at levels between >0% and >50%.



4.8 Gaps analysis by bioregion: outlying islands

Kermadec Islands

All of the 11 coastal habitats found in this bioregion are contained in the Kermadec Islands Marine Reserve (Table 17 in Appendix 3).

Three Kings Islands

No MPAs are located in this bioregion.

Chatham Islands

No MPAs are located in this bioregion.

Snares Islands

No MPAs are located in this bioregion.

Subantarctic Islands

Marine reserves	4
Type 2 MPAs	2
Extent of bioregion in an MPA	100%
Habitats	20
Habitats represented in a marine reserve	20
Habitats with <1% of their extent in a marine reserve	0
Habitats with >10% of their extent in a marine reserve	20
Extent of habitats represented in a marine reserve	65.64–100%
Habitats represented in an MPA	20 (Table 18)
Habitats with <1% of their extent in an MPA	0
Habitats with >10% of their extent in an MPA	20
Extent of habitats represented in an MPA	100%
Habitats not represented in an MPA include	n/a
Replication	not assessed

5 Discussion

5.1 Summary of gaps in representativity and replication

This report presents an analysis of the habitats within MPAs in the New Zealand territorial sea, according to a defined habitat classification (Ministry of Fisheries and Department of Conservation, 2008). The analysis did not assess habitat representativity in the exclusive economic zone.

The analysis highlights the significant gaps in the representativity and replication of habitats in MPAs across the territorial sea, apart from the Subantarctic Islands and Kermadec Islands bioregions. In these 2 bioregions, all of the territorial sea is in MPAs.

In 9 of the 14 bioregions, 50% or more of the habitats are not represented in an MPA. Three bioregions have no MPAs. Only 2 bioregions (Subantarctic Islands and Kermadec Islands) have more than half of their habitats represented in a marine reserve.

For all 416 habitats, 70% have <1% of their overall extent within an MPA. Some habitats are well-represented in MPAs in terms of their regional extent. Habitats in Fiordland generally have a higher percentage of their regional extent within an MPA – more than one fifth of habitats in this bioregion have at least 10 percent of their area within an MPA, and one habitat has almost complete coverage. However, half of the habitats in Fiordland are not in any MPA.

For other bioregions such as North Eastern, the level of replication for some habitats was relatively high, but the representativity of these habitats in an MPA was low. This type of disparity between metrics is common in many bioregions. It highlights the importance of not relying on one metric to assess how well a bioregion is meeting the requirements of an MPA network.

5.2 Benefits of a systematic conservation planning approach

A systematic conservation planning approach would help to achieve an adequate habitat representativity and replication in an MPA network for New Zealand. It would allow for the identification of optimal areas for MPA placement that would achieve the MPA network design principles (see below) and objectives for marine protection, while minimising impacts on existing users of the marine environment.

The benefits of such a strategic approach to marine spatial planning have been demonstrated in a range of spatial planning processes, as well as by testing and evaluating different scenarios in New Zealand (Geange et al., 2017, Leathwick et al., 2006, Leathwick et al., 2008).

5.3 Assumptions and caveats

To achieve this gaps analysis, a number of limits and assumptions were applied.

Alignment with MPA design criteria

The analysis considers only the representativity of broad-scale habitats in MPAs for the territorial sea. It does not consider other aspects of MPA network design, such as

connectivity, adequacy and the protection of ecologically important areas. For example, how adequately individual MPAs protect the marine species and habitats within their boundaries was not assessed in this study.

It has been assumed that if a particular habitat (as defined by the classification) is present within an MPA, then the biodiversity associated with that habitat was also protected. A range of studies, however, show that this assumption does not always hold; some aspects of MPA design (like size and boundary placement) have an effect on the effectiveness and adequacy of an MPA (e.g. Bartholomew et al., 2008, Kramer and Chapman, 1999).

Replication was assessed simply as the presence of a habitat within an MPA, regardless of the size of that MPA or the adequacy of protection. The large Fiordland Marine Area type 2 MPA was treated as a single MPA in this analysis for example. The Kermadec Islands Marine Reserve could be viewed as a single example for the Kermadec Islands bioregion, but in fact protects multiple examples of different habitats within its boundaries and therefore provides replication.

The analysis does not take the need for connectivity in an MPA network into account. Replication of habitats does not automatically mean that they are connected – their location and spacing also needs to be taken into account (Kaplan and Botsford, 2005, Shanks et al., 2003). Their connectivity with adjacent land and exclusive economic zone habitats should also be considered. Many other social, cultural and economic values should also be taken into account when designing an MPA network and in the associated planning process.

Use of a broad-scale habitat classification system

Most MPAs assessed in this study were established well before the broad-scale habitat classification was developed and were not designed nor located to achieve representativity of those habitats. Consequently, there is an element of 'shifting the goal posts' with this current analysis (and this could also be encountered if any new classification system is used for MPA planning and reporting). This analysis does, however, show where efforts to consider protected areas could be focussed in the future.

The use of the broad-scale classification scheme does not adequately consider rare or unique habitats or those that are of particular ecological importance. Data relating to the distribution of these habitats should be considered alongside the broad-scale habitat mapping used in this analysis.

There are a range of known issues with the broad-scale habitat classification scheme used in this analysis (Rowden et al., 2018) e.g. it has been mapped at a national scale and has not been ground-truthed at that scale. (Ground-truthing involves checking that the predicted habitats are actually present at a location).

Mapping errors

There are known errors with the national scale maps (Rowden et al., 2018). These would need to be addressed during any future MPA planning process, using regional data sets and local ecological knowledge, and may result in quite different depictions of habitat representation than those presented in this report.

Revised habitat maps are available for the Hauraki Gulf (they were developed to inform the Sea Change marine spatial planning process) and part of the southern South Island coast (developed for the Southeast MPA Forum planning region). However, there were difficulties in aligning these with the rest of the national classifications, so the 2011 version of the classification was used.

Some minor technical problems were also encountered when the classifications and MPAs were mapped. For the Kermadec and Subantarctic Islands, the mapped habitat classification did not precisely align with the mapped protected areas. For the cable protection zones, overlaying the habitat classification resulted in areas of intertidal habitat being included whereas the landward boundary of cable protection zones is low water.

Assumptions in the classification system

The classification system assumes:

(1) the biodiversity associated with each habitat is distinct from the biodiversity associated with other habitats (and from the same habitat in other bioregions)

(2) the biodiversity associated with each habitat is the same across a bioregion.

These assumptions have rarely been tested and the adequacy of the classification system has been questioned in at least one bioregion (Freeman et al., 2011). Further work to better understand how well the current classification represents patterns in biodiversity is required. In the interim, this gaps analysis should be treated as indicative only.

Pelagic habitats

The current coastal classification scheme does not consider pelagic habitats. Pelagic habitats support biodiversity that can be distinct from and function independently of benthic habitats. To fully represent biodiversity within a network of MPAs, pelagic habitats should be considered alongside those that occur on the seabed.

Pelagic habitats have been recommended for inclusion in MPA planning processes (Conference of the Parties to the Convention on Biological Diversity, 2008) and should be part of any future MPA or spatial planning process.

This analysis did not consider the representativity of habitats that may be important for particular species (such as protected species) or the ranges of these species. If MPAs were established to protect specific species that are not closely associated with the benthic habitats included in the classification system, other ecosystem components would need to be considered. These include currents, upwelling, biogeochemistry, productivity and sea surface temperature.

Viability of an MPA

In this study presence-absence information and various degrees of habitat coverage indicate the representativity of habitats in MPAs. No assessment of whether the proportion of a habitat that occurred within an MPA was of sufficient size to ensure the ecological viability of that habitat and its associated biological communities was undertaken.

One area recommended for future work is the consideration of habitat-specific targets for representativity. There are known differences in the number of species associated with different habitats. To achieve a network of MPAs that fully represents New Zealand's biodiversity, it may be more effective to use habitat-specific data, where available, rather than a blanket target across all habitats. This approach has been suggested for the United Kingdom (Rondinini, 2010) but relies on knowledge of species-area relationships, which are not always available.

Meeting the protection standard

For the purposes of this analysis we did not revisit the assessment of which protected or managed areas meet the protection standard (Ministry of Fisheries and Department of

Conservation, 2008). Existing marine reserves and type 2 MPAs were assessed in terms of habitat representativity.

A particular information gap is noted: how well each habitat type is protected by each type of MPA. For example, while habitats such as rocky reefs are present in a number of cable protection zones, the particular regulations relating to those areas mean that there may not be any effective protection for those habitats. Further assessment of the degree to which different protected or managed areas provide protection to species and habitats should be undertaken.

An assessment of the degree to which protected areas like marine mammal sanctuaries, wildlife sanctuaries and government purpose reserves[7] protect species and habitats (and therefore contribute to representativity of habitats) would also be useful. This work may involve assessing the particular management objectives of these protected areas and any management restrictions that may impart some protection to marine species and/or habitats.

[7] Government purpose reserves are a class of reserve provided for in section 22 of the Reserves Act. In the case of new reserves, these purposes are generally limited to conservation-related purposes, such as management of wildlife or scenic features.

6 Summary and recommendations

New Zealand's MPAs do not currently provide protection for a fully representative range of broad-scale habitats. Most habitats have insufficient replication across MPAs. This applies to all nine mainland bioregions and to three of the five outlying island bioregions.

A full assessment of representativity and replication needs to consider other MPA network design principles, such as connectivity, viability and adequacy.

The authors recommend:

1. Addressing deficiencies with the current CCMS. This should include an assessment of how well the habitat classifications represent actual patterns of biodiversity.
2. Assessing the proportion of a habitat that needs to be in an MPA to ensure the ecological viability of that habitat and its associated biological assemblages. This could include developing habitat-specific targets for protection and considering threats to particular habitats.
3. Assessing how well existing MPAs and other protection and management tools are providing protection for species or habitats.

Work is in progress on the first point above (Rowden et al., 2018). Network design principles to inform the development and implementation of future MPAs in New Zealand (e.g. Lundquist et al., 2015) are also being considered.

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9 Appendix 1

Table 6: Existing marine reserves as at June 2019.

Bioregion	Official (Order in Council) name	Region	Area (km²) from GIS, using NZTM	Area (km²) in Order in Council or Act	Area (ha) in Order in Council or Act	Year est.	Legislative instrument
Kermadec Islands	Kermadec Islands Marine Reserve	Kermadec Islands	7674.886883	7480	748000	1990	Marine Reserves Act 1971
Western North Island	Parininihi Marine Reserve	Taranaki	18.45928362	18.44	1844	2006	Marine Reserves Act 1971
	Tapuae Marine Reserve	Taranaki	14.04990391	14.043	1404.3	2008	Marine Reserves Act 1971
North Cook Strait	Kapiti Marine Reserve	Wellington	21.66553512	21.67	2167	1992	Marine Reserves Act 1971
	Taputeranga Marine Reserve	Wellington	8.545523065	8.547915	854.7915	2008	Marine Reserves Act 1971
Eastern North Island	Te Angiangi Marine Reserve	Hawke's Bay	4.439183067	4.46	446	1997	Marine Reserves Act 1971
	Te Tapuwae o Rongokako Marine Reserve	Gisborne	24.72307791	24.52	2452	1999	Marine Reserves Act 1971
North Eastern	Cape Rodney-Okakari Point Marine Reserve	Auckland	5.561405461	n/a	n/a	1975	Marine Reserves Act 1971
	Long Bay-Okura Marine Reserve	Auckland	9.627256657	9.8	980	1995	Marine Reserves Act 1971
	Motu Manawa-Pollen Island Marine Reserve	Auckland	5.014944625	5	500	1995	Marine Reserves Act 1971
	Poor Knights Islands Marine Reserve	Northland	19.22125087	24.1	2410	1981	Marine Reserves Act 1971
	Tāwharanui Marine Reserve	Auckland	3.942513745	3.942	394.2	2011	Marine Reserves Act 1971
	Te Matuku Marine Reserve	Auckland	6.880992912	6.896	689.6	2005	Marine Reserves Act 1971
	Te Paepae o Aotea (Volkner Rocks) Marine Reserve	Bay of Plenty	12.76566457	12.6724	1267.24	2006	Marine Reserves Act 1971
	Tuhua (Mayor Island) Marine Reserve	Bay of Plenty	10.55151047	10.6	1060	1992	Marine Reserves Act 1971
	Whanganui A Hei (Cathedral Cove) Marine Reserve	Waikato	8.791524441	8.4	840	1992	Marine Reserves Act 1971
	Whangarei Harbour Marine Reserve	Northland	2.392269223	2.3651	236.51	2006	Marine Reserves Act 1971
South Cook Strait	Horoirangi Marine Reserve	Nelson	9.079990626	9.037	903.7	2005	Marine Reserves Act 1971
	Long Island—Kokomohua Marine Reserve	Marlborough	6.230724902	6.19	619	1993	Marine Reserves Act 1971
	Tonga Island Marine Reserve	Tasman	18.28335074	18.35	1835	1993	Marine Reserves Act 1971
	Westhaven (Te Tai Tapu) Marine Reserve	Tasman	5.417851015	5.357	535.7	1994	Marine Reserves Act 1971
West Coast South Island	Hautai Marine Reserve	West Coast	8.54476437	8.533	853.3	2014	Marine Reserves Act 1971
	Kahurangi Marine Reserve	West Coast	84.05676135	84.1886	8418.86	2014	Marine Reserves Act 1971
	Punakaiki Marine Reserve	West Coast	35.1912095	35.2029	3520.29	2014	Marine Reserves Act 1971

Bioregion	Official (Order in Council) name	Region	Area (km²) from GIS, using NZTM	Area (km²) in Order in Council or Act	Area (ha) in Order in Council or Act	Year est.	Legislative instrument
	Tauparikākā Marine Reserve	West Coast	0.164493235	0.1662	16.62	2014	Marine Reserves Act 1971
	Waiau Glacier Coast Marine Reserve	West Coast	45.60055476	45.57419	4557.419	2014	Marine Reserves Act 1971
Fiordland	Hawea (Clio Rocks) Marine Reserve	Southland	4.019380289	4.11	411	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Kahukura (Gold Arm) Marine Reserve	Southland	4.74481608	4.64	464	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Kutu Parera (Gaer Arm) Marine Reserve	Southland	4.163392182	4.33	433	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Moana Uta (Wet Jacket Arm) Marine Reserve	Southland	20.12784219	20.07	2007	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Piopiotahi (Milford Sound) Marine Reserve	Southland	7.155599843	6.9	690	1993	Marine Reserves Act 1971
	Taipari Roa (Elizabeth Island) Marine Reserve	Southland	6.159664887	6.13	613	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Taumoana (Five Finger Peninsula) Marine Reserve	Southland	14.8048561	14.66	1466	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Te Awaatu Channel (The Gut) Marine Reserve	Southland	0.935747873	0.93	93	1993	Marine Reserves Act 1971
	Te Hapua (Sutherland Sound) Marine Reserve	Southland	4.526960911	4.49	449	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
	Te Tapuwae o Hua (Long Sound) Marine Reserve	Southland	36.91803727	36.72	3672	2005	Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
Southern South Island	Ulva Island—Te Wharawhara Marine Reserve	Southland	10.79396878	10.751	1075.1	2004	Marine Reserves Act 1971
East Coast South Island	Akaroa Marine Reserve	Canterbury	4.816903784	5.1215	512.15	2014	Marine Reserves Act 1971
	Hikurangi Marine Reserve	Canterbury	103.9548717			2014	Kaikōura (Te Tai o Marokura) Marine Management Act 2014
	Pohatu Marine Reserve	Canterbury	2.339354166	2.153	215.3	1999	Marine Reserves Act 1971
Subantarctic Islands	Auckland Islands—Motu Maha Marine Reserve	Subantarctic Islands	5057.096416	4980	498000	2003	Marine Reserves Act 1971

Bioregion	Official (Order in Council) name	Region	Area (km²) from GIS, using NZTM	Area (km²) in Order in Council or Act	Area (ha) in Order in Council or Act	Year est.	Legislative instrument
	Moutere Hauriri/Bounty Islands Marine Reserve	Subantarctic Islands	1046.327566	1046.258005	104625.8005	2014	Subantarctic Islands Marine Reserves Act 2014
	Moutere Ihupuku/Campbell Island Marine Reserve	Subantarctic Islands	1131.334323	1132.506863	113250.6863	2014	Subantarctic Islands Marine Reserves Act 2014
	Moutere Mahue/Antipodes Island Marine Reserve	Subantarctic Islands	2173.100012	2172.866633	217286.6633	2014	Subantarctic Islands Marine Reserves Act 2014

10 Appendix 2

Table 7: Type 2 MPAs as at June 2019.

Bioregion	Official (Order in Council) name	Region	Designation	IUCN category	Area (km²) from GIS layer NZTM (14 Jun 2017)	Year est.	Managing authority	Legislation
Western North Island	Muriwai Beach Submarine Cable Closure	Auckland	Cable closure		313.990703	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
	Pohokura Submarine Cable Closure	Taranaki	Cable closure		8.077809	2006	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2006
	Sugar Loaf Islands Marine Protected Area	Taranaki	Marine park	V	4.226946	1991	Department of Conservation, Ministry for Primary Industries	Sugar Loaf Islands Marine Protected Area Act 1991; Fisheries (Central Area Commercial Fishing) Regulations 1986; Fisheries (Amateur Fishing) Regulations 2013
North Cook Strait	Cook Strait Submarine Cable Closure	Wellington	Cable closure		235.719906	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
	Oaonui Submarine Cable Closure	Taranaki	Cable closure		141.688157	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
	Pukerua Bay Fisheries Closure	Wellington	Fisheries closure		2.044640	2009	Ministry for Primary Industries	Fisheries (Central Area Commercial Fishing) Regulations 1986; Fisheries (Amateur Fishing) Regulations 2013
North Eastern	Great Barrier Island Submarine Cable Closure	Auckland	Cable closure		23.718138	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009

Bioregion	Official (Order in Council) name	Region	Designation	IUCN category	Area (km²) from GIS layer NZTM (14 Jun 2017)	Year est.	Managing authority	Legislation
	Hauraki Gulf Submarine Cable Closure	Auckland	Cable closure		850.318111	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
	Kawau Island Submarine Cable Closure	Auckland	Cable closure		3.809402	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
	Mimiwhangata Marine Park	Northland	Marine park		18.550819	2005	Ministry for Primary Industries	Fisheries (Auckland and Kermadec Areas Amateur Fishing) Regulations 1986; Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986
	Whangaparaoa Peninsula Submarine Cable Closure	Auckland	Cable closure		0.726454	2009	Ministry of Transport	Submarine Cables and Pipelines Protection Act 1996; Submarine Cables and Pipelines Protection Order 2009
West Coast South Island	Punakaiki North	West Coast	Fisheries closure		1.328640	2015	Ministry for Primary Industries	Fisheries (Challenger Area Commercial Fishing) Regulations 1986
	Punakaiki South	West Coast	Fisheries closure		1.937062	2015	Ministry for Primary Industries	Fisheries (Challenger Area Commercial Fishing) Regulations 1986
	Hautai	West Coast	Fisheries closure		102.023262	2015	Ministry for Primary Industries	Fisheries (Challenger Area Commercial Fishing) Regulations 1986
Fiordland	Fiordland (Te Moana o Atawhenua) Marine Area	Southland	Marine area		378.200059	2005	Ministry for Primary Industries	Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986; Fisheries (Amateur Fishing) Regulations 2013
Southern South Island	Paterson Inlet Fisheries Closure	Southland	Fisheries closure		13.578540	1993	Ministry for Primary Industries	Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986; Fisheries (Amateur Fishing) Regulations 2013
	Te Whaka ā Te Wera Mātaitai Reserve	Southland	Mataitai reserve		77.346750	2004	Ministry for Primary Industries	Fisheries (Kaimoana Customary Fishing) Regulations 1998

Bioregion	Official (Order in Council) name	Region	Designation	IUCN category	Area (km²) from GIS layer NZTM (14 Jun 2017)	Year est.	Managing authority	Legislation
Subantarctic Islands	Moutere Hauriri/Bounty Islands (bottom trawling and Danish seine prohibition)	Subantarctic Islands	Fisheries closure		754.885372	2014	Ministry for Primary Industries	Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986
	Motu Ihupuku/Campbell Island (bottom trawling and Danish seine prohibition)	Subantarctic Islands	Fisheries closure		1761.350513	2014	Ministry for Primary Industries	Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986

11 Appendix 3

Habitat representativity and replication within MPAs is shown in tables 8–18. Mean high water is abbreviated as MHW.

Table 8. Western North Island

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic mangrove	87.53337052	0	0	0			
Biogenic mangrove above MHW	4.175945449	0	0	0			
Biogenic saltmarsh	12.25400568	0	0	0			
Biogenic saltmarsh above MHW	1.181260854	0	0	0			
Biogenic seagrass	63.23518106	0	0	0			
Biogenic seagrass above MHW	1.419050871	0	0	0			
Deep gravel	18.78776603	0	0	0			
Deep mud	1179.853042	0	0	0			
Deep reef	9.782234602	0	0	0			
Deep sand	9025.538146	0.003995607	2.9222871	2.926283	1	3	4
Estuarine	0.024447555	0	0	0			
Estuarine beach	15.39506464	0	0	0			
Estuarine mud	1.945205436	0	0	0			
Estuarine reef	0.847256827	0	0	0			
Estuarine rocky shore	1.40293185	0	0	0			
Estuarine sand	513.307706	0	0	0			
Exposed beach	36.47798702	0	2.61582261	2.615823		1	1

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Exposed rocky shore	6.646316621	0	7.13761595	7.137616		1	1
Exposed shallow gravel	22.74950469	0	0	0			
Exposed shallow reef	62.87040553	0	0.002409396	0.002409		1	1
Exposed shallow sand	1858.500845	0.00093013	2.858739046	2.859669	1	3	4
High current beach	0.417040153	0	0	0			
High current deep sand	5.309740225	0	0	0			
High current rocky shore	0.536390415	0	0	0			
High current shallow reef	2.028401564	0	0	0			
High current shallow sand	201.6041838	0	0	0			
Moderate beach	4.883257612	2.447986379	0.493576744	2.941563	2	1	3
Moderate rocky shore	3.278352278	12.66559838	0	12.6656	1		1
Moderate shallow gravel	0.384044862	0	0	0			
Moderate shallow reef	51.04399265	12.64064926	2.737394375	15.37804	2	1	3
Moderate shallow sand	639.5923675	3.876229367	0.873954331	4.750184	2	2	4
Mudflat	507.249015	0	0	0			
Shallow mud	10.91430695	1.475545273	8.387766703	9.863312	1	1	2
Sheltered beach	0.561953186	0	0	0			
Sheltered rocky shore	0.080333347	0	0	0			
Sheltered shallow reef	1.293765706	0	0	0			
Sheltered shallow sand	7.865771346	0	0	0			
Upper slope	185.6759822	0	0	0			

Table 9. North Cook Strait

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic saltmarsh	0.003280134	0	0	0			
Biogenic saltmarsh above MHW	0.000955039	0	0	0			
Biogenic seagrass	1.761349323	0	0	0			
Biogenic seagrass above MHW	3.40101E-06	0	0	0			
Deep gravel	149.6663144	0	16.22387597	16.22388		1	1
Deep mud	3265.002816	0	2.515872248	2.515872		1	1
Deep reef	42.48729812	0.171231025	0	0.171231	1		1
Deep sand	2025.939683	0.057518791	0.685421595	0.74294	1	1	2
Estuarine	34.91826939	0	0	0			
Estuarine beach	0.370349262	0	0	0			
Estuarine mud	36.04380462	0	0	0			
Estuarine reef	10.57678507	0	0	0			
Estuarine rocky shore	0.793855077	0	0	0			
Estuarine sand	11.46645099	0	0	0			
Exposed beach	2.530430502	0	7.881297721	7.881298		1	1
Exposed rocky shore	6.30814254	0	11.33307247	11.33307		1	1
Exposed shallow gravel	50.1278581	0	28.43147647	28.43148		1	1
Exposed shallow reef	119.9110549	0	5.053958502	5.053959		1	1
Exposed shallow sand	167.6063585	0	0.018218312	0.018218		1	1
High current beach	0.720432614	4.419501134	0	4.419501	1		1
High current deep gravel	432.28993	0	11.70469703	11.7047		1	1
High current deep mud	152.4119306	2.326687576	0	2.326688	1		1
High current deep reef	8.948181132	4.146136468	6.060341523	10.20648	2	1	3

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
High current deep sand	1474.539107	0.930897299	0.818401648	1.749299	2	1	3
High current rocky shore	1.514256874	10.74686112	0	10.74686	1		1
High current shallow gravel	108.98477	0	0	0			
High current shallow reef	53.00070264	6.269775529	0.744629904	7.014405	2	1	3
High current shallow sand	499.0404508	0.625479409	0.239919167	0.865399	2	1	3
Lower slope	755.524659	0	0	0			
Mid slope	1092.950225	0	0	0			
Moderate beach	8.214801603	0	0	0			
Moderate rocky shore	6.3976082	1.395198728	1.761845692	3.157044	1	1	2
Moderate shallow gravel	39.54470723	0	0	0			
Moderate shallow reef	165.9275304	1.776673904	0.853011427	2.629685	1	1	2
Moderate shallow sand	707.2533769	0.201065446	0.10741724	0.308483	1	1	2
Mudflat	0.272292772	0	0	0			
Shallow mud	413.8914742	0	0.036141246	0.036141		1	1
Sheltered beach	8.028518413	0	0.24169631	0.241696		1	1
Sheltered rocky shore	1.930781282	0	25.57901414	25.57901		1	1
Sheltered shallow gravel	11.71769616	0	0	0			
Sheltered shallow reef	19.82603854	0	7.097329795	7.09733		1	1
Sheltered shallow sand	516.4881464	0	0.023731999	0.023732		1	1
Upper slope	1248.754378	0.00	2.4154529	2.415453		1	1

Table 10. Eastern North Island

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic saltmarsh	0.587108623	0		0			
Biogenic saltmarsh above MHW	0.028506802	0		0			
Deep gravel	171.9800024	0		0			
Deep mud	7025.748905	0.022146588		0.022146588	2		2
Deep reef	110.2593962	2.83745328		2.83745328	1		1
Deep sand	951.7408067	0.668063487		0.668063487	2		2
Estuarine	16.58005934	0		0			
Estuarine beach	1.748312217	0.000175313		0.000175313	1		1
Estuarine mud	0.264169998	0		0			
Estuarine reef	0.050544514	0		0			
Estuarine sand	0.105028883	0		0			
Exposed beach	1.632431103	7.637584861		7.637584861	1		1
Exposed rocky shore	8.775397194	8.377402412		8.377402412	1		1
Exposed shallow reef	174.0834155	5.539276793		5.539276793	1		1
Exposed shallow sand	50.77397735	4.650479621		4.650479621	1		1
High current beach	0.062408612	0		0			
High current deep mud	217.8073542	0		0			
High current deep reef	1.925837903	0		0			
High current deep sand	0.807636182	0		0			
High current rocky shore	0.314977778	0		0			
High current shallow mud	8.645550738	0		0			
High current shallow reef	22.27712884	0		0			

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
High current shallow sand	2.448330673	0		0			
Lower slope	30.74874922	0		0			
Mid slope	175.0130905	0		0			
Moderate beach	7.467119336	2.392229424		2.392229424	1		1
Moderate rocky shore	12.39496729	2.836380173		2.836380173	1		1
Moderate shallow gravel	219.0374069	0		0			
Moderate shallow reef	284.8369983	0.839125175		0.839125175	1		1
Moderate shallow sand	834.5079264	0.156175511		0.156175511	1		1
Mudflat	1.336780993	0		0			
Shallow mud	599.9069778	0.134312829		0.134312829	2		2
Sheltered beach	1.856762837	0		0			
Sheltered rocky shore	0.643280517	0		0			
Sheltered shallow gravel	3.404510575	0		0			
Sheltered shallow reef	6.471878688	0		0			
Sheltered shallow sand	103.1600366	0		0			
Upper slope	587.7004078	0		0			

Table 11. North Eastern

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic dog cockles	239.5747283	0.273673797	3.250259051	3.523933	2	1	3
Biogenic green-lipped mussel	2.25485492	0	0.290222331	0.290222		1	1
Biogenic mangrove	112.5609873	2.573673178	0	2.573673	4		4
Biogenic mangrove above MHW	0.262928234	0	0	0			
Biogenic rhodoliths	51.38383021	0	7.889364726	7.889365		2	2
Biogenic saltmarsh	14.98228419	0.434997944	0	0.434998	3		3
Biogenic saltmarsh above MHW	1.966673821	2.02299163	0	2.022992	3		3
Biogenic seagrass	65.64763671	0	0	0			
Biogenic seagrass above MHW	0.054198463	0	0	0			
Biogenic spirits bay	222.4749236	0	0	0			
Deep gravel	220.7027448	0	3.720469551	3.72047		1	1
Deep mud	8841.765835	0.029963981	3.881712079	3.911676	1	2	3
Deep reef	251.819881	6.100627795	1.692157463	7.792785	3	2	5
Deep sand	13044.07289	0.102831602	3.435756818	3.538588	5	3	8
Estuarine	0.120314876	0	0	0			
Estuarine beach	117.6838387	0.024800581	0.063803646	0.088604	1	1	2
Estuarine gravel	0.226141505	0	0	0			
Estuarine mud	33.20903291	0	4.406021947	4.406022		1	1
Estuarine reef	33.99645848	0.187388899	6.663948899	6.851338	1	1	2
Estuarine rocky shore	4.492112515	0	2.265822192	2.265822		1	1
Estuarine sand	317.9241879	0.928901609	0	0.928902	4		4
Exposed beach	5.968133846	0	0	0			
Exposed rocky shore	0.424212231	0	0	0			

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Exposed shallow gravel	14.83765362	0	0	0			
Exposed shallow reef	6.187638386	0	0	0			
Exposed shallow sand	230.9622665	0	0	0			
High current beach	41.03406081	0	0	0			
High current deep gravel	142.2364658	0	0	0			
High current deep mud	271.7782919	0	0.576743038	0.576743		1	1
High current deep reef	9.812463843	0	0.748912071	0.748912		1	1
High current deep sand	1861.877528	0	0.059410508	0.059411		1	1
High current rocky shore	2.095244687	0	0	0			
High current shallow gravel	96.52246648	0	0	0			
High current shallow mud	324.864326	0	0	0			
High current shallow reef	40.99645796	0	0	0			
High current shallow sand	229.7104688	0.074322577	0	0.074323	1		1
Lower slope	663.909012	0	0	0			
Mid slope	2247.581381	0	0	0			
Moderate beach	33.35730907	0.531485265	0.86917377	1.400659	2	2	4
Moderate rocky shore	26.34036426	1.839572386	1.279868077	3.11944	3	2	5
Moderate shallow gravel	27.42311961	0	9.428183617	9.428184		2	2
Moderate shallow reef	493.6244621	2.017858743	2.003359147	4.021218	6	3	9
Moderate shallow sand	1894.487373	0.538240207	0.197369239	0.735609	5	3	8
Mudflat	251.4179621	1.959892264	0	1.959892	4		4
Shallow mud	1364.121746	0.418135587	4.206383559	4.624519	3	2	5
Sheltered beach	9.198698992	0.340072382	0.519416341	0.859489	1	2	3
Sheltered rocky shore	16.85493694	0.971010632	0.521941065	1.492952	2	2	4
Sheltered shallow gravel	30.84476607	0	0	0			
Sheltered shallow reef	110.9979575	0.912776691	0.222657653	1.135434	2	2	4
Sheltered shallow sand	697.1908989	0.761289453	0.117496365	0.878786	2	2	4

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Upper slope	3526.123028	0.204524523	0	0.204525	1		1

Table 12. South Cook Strait

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic saltmarsh	4.985196149	0.006779356	0.000779858	0.007559	2	1	3
Biogenic saltmarsh above MHW	2.404402719	0	0	0			
Biogenic seagrass	49.42387279	0.29500178	0	0.295002	1		1
Biogenic seagrass above MHW	0.012506316	0	0	0			
Biogenic silt/bryozoan mounds	53.60613017	0	0	0			
Deep gravel	468.0761239	0	0	0			
Deep mud	2167.672614	0.04219693	0	0.042197	1		1
Deep reef	17.93456397	0	0.24312823	0.243128		1	1
Deep sand	2092.030565	0	0.111764799	0.111765		1	1
Estuarine	0.021256572	0	0	0			
Estuarine beach	13.93914829	0.166580054	0	0.16658	1		1
Estuarine gravel	0.085242918	0	0	0			
Estuarine mud	333.735297	0.183614037	0	0.183614	1		1
Estuarine reef	99.19519802	1.405003379	0	1.405003	1		1
Estuarine rocky shore	0.763038116	0	0	0			
Estuarine sand	287.7344915	1.309774955	0	1.309775	2		2
Exposed beach	2.56334986	0	0	0			
Exposed rocky shore	1.98554857	0	0	0			
Exposed shallow gravel	4.3030155	0	0	0			
Exposed shallow reef	23.9484641	0	0	0			
Exposed shallow sand	95.79761683	0	0	0			
High current beach	1.119132735	0	0	0			
High current deep gravel	545.2996904	0	15.59475235	15.59475		1	1
High current deep mud	307.8578005	0.066810824	0	0.066811	1		1

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
High current deep reef	28.99886939	0.006576903	0.210227466	0.216804	1	1	2
High current deep sand	3208.692316	0.015125121	1.428403032	1.443528	1	1	2
High current rocky shore	0.213476549	0	8.737600303	8.7376		1	1
High current shallow gravel	13.07945398	0	0	0			
High current shallow mud	106.4558129	0	0	0			
High current shallow reef	37.86242132	0.32655291	0.36044337	0.686996	1	1	2
High current shallow sand	264.1788421	0.100513107	0.105656882	0.20617	1	1	2
Moderate beach	0.078537575	0	0	0			
Moderate rocky shore	0.052222044	0	0	0			
Moderate shallow reef	13.49034313	0	0	0			
Moderate shallow sand	94.5010603	0	0	0			
Mudflat	158.5250758	2.569193152	0	2.569193	1		1
Shallow mud	1177.397706	1.827845402	0	1.827845	2		2
Sheltered beach	10.66016694	0.543429818	0	0.54343	1		1
Sheltered rocky shore	3.512456766	7.920746701	7.497333781	15.41808	2	1	3
Sheltered shallow gravel	0.734648831	0	0	0			
Sheltered shallow reef	61.35048311	6.803615881	2.670589784	9.474206	2	1	3
Sheltered shallow sand	306.4846713	0.013962413	0.965755444	0.979718	1	1	2
Upper slope	162.040677	0	0.036246787	0.036247		1	1

Table 13. West Coast South Island

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic saltmarsh	0.977351668	0	0.00	0			
Biogenic saltmarsh above MHW	0.149448875	0	0.00	0			
Deep gravel	21.25346069	0	0.00	0			
Deep mud	6027.167696	0.234903443	0.63	0.866793	2	1	3
Deep reef	74.51079647	1.848040788	24.68	26.52664	1	1	2
Deep sand	2042.660257	1.62978234	0.00	1.629782	2		2
Estuarine	0.255525759	0.076502937	0.00	0.080509	1	1	2
Estuarine beach	2.506612855	0	0.00	8.42E-06		1	1
Estuarine sand	0.977751789	0	0.00	0			
Exposed beach	12.22457582	7.701385086	2.82	10.52522	4	3	7
Exposed rocky shore	5.710657944	3.721471261	6.73	10.44692	2	1	3
Exposed shallow gravel	0.988544703	0	0.00	0			
Exposed shallow reef	123.594652	7.62288848	5.95	13.57488	3	3	6
Exposed shallow sand	1651.831879	6.121700469	0.13	6.247885	3	2	5
Lower slope	773.4089753	0	0.00	0			
Mid slope	858.7749071	0	3.33	3.330797		1	1
Moderate beach	3.659239904	0	0.00	0			
Moderate rocky shore	0.677840128	0	0.00	0			
Moderate shallow reef	11.39184253	0	0.00	0			
Moderate shallow sand	419.6784213	0	0.00	0			
Shallow mud	492.4823031	2.212089847	0.00	2.21209	3		3
Upper slope	584.7798022	0	0.00	0			

Table 14. Fiordland

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Deep gravel	24.29	0	0	0			
Deep mud	462.33	0	0.02345222	0.023452		1	1
Deep reef	125.02	0	0.009411559	0.009412		1	1
Deep sand	1724.39	0	0	0			
Estuarine	10.39	0.000905709	0	0.000906	1		1
Estuarine beach	4.35	14.59634191	0.148376439	14.74472	4	1	5
Estuarine mud	458.38	11.98958472	0.616073445	12.60566	9	1	10
Estuarine reef	171.74	9.586512301	33.90798424	43.4945	10	1	11
Estuarine rocky shore	3.55	3.364658274	4.329505238	7.694164	1	1	2
Estuarine sand	151.59	19.63917118	27.16905076	46.80822	1	1	2
Exposed beach	1.20	0	0	0			
Exposed rocky shore	20.66	0	0.00577323	0.005773		1	1
Exposed shallow reef	279.35	0	0.016035328	0.016035		1	1
Exposed shallow sand	60.53	0	0	0			
High current deep mud	1.31	0	0	0			
High current deep reef	1.08	0	0	0			
High current deep sand	200.64	0	0	0			
High current rocky shore	0.03	0	0	0			
High current shallow reef	2.59	0	0	0			
High current shallow sand	0.35	0	0	0			
Lower slope	3449.88	0	0	0			
Mid slope	1394.08	0	0	0			
Mudflat	1.01	70.48232087	26.47228916	96.95461	4	1	5
Shallow mud	52.45	0	0.107328648	0.107329		1	1

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Sheltered shallow reef	0.08	0	33.76278569	33.76279		1	1
Upper slope	1639.90	0	0	0			

Table 15. Southern South Island

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic bryozoans	87.18	0	0	0			
Biogenic high relief biogenic reef	11.09	0	0	0			
Biogenic low relief biogenic reef	42.62	0	0	0			
Biogenic mussel	0.05	0	100	100		1	1
Biogenic saltmarsh	2.51	0	0.000363232	0.000363		1	1
Biogenic saltmarsh above MHW	0.97	0	0.001018075	0.001018		1	1
Biogenic seagrass	11.18	0	31.46218991	31.46219		1	1
Biogenic seagrass above MHW	0.35	0	0.60252357	0.602524		1	1
Biogenic serpulid worm patch reefs (*Galeolaria hystrix*)	1.88	22.70828425	76.79083781	99.49912	1	2	3
Deep gravel	1259.80	0	0	0			
Deep mud	527.95	0	0	0			
Deep reef	69.22	0	0	0			
Deep sand	7899.14	0	0	0			
Estuarine	1.07	0	0	0			
Estuarine beach	1.99	0.978619302	25.86800449	26.84662	1	2	3
Estuarine gravel	37.46	1.852791929	49.04164852	50.89444	1	2	3
Estuarine mud	31.71	7.970248631	72.90717071	80.87742	1	2	3
Estuarine reef	43.44	3.421493296	32.8890321	36.31053	1	2	3
Estuarine rocky shore	0.35	0	18.09345596	18.09346		1	1
Estuarine sand	76.08	4.415685985	17.00396748	21.41965	1	2	3
Exposed beach	12.66	0	0	0			
Exposed rocky shore	9.32	0.057083703	0	0.057084	1		1
Exposed shallow gravel	141.68	0	0	0			

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Exposed shallow reef	214.54	0	0	0			
Exposed shallow sand	1221.30	0	0	0			
High current beach	24.26	0	0	0			
High current deep gravel	1161.75	0.000190617	0.009726303	0.009917	1	1	2
High current deep reef	31.26	0	0	0			
High current deep sand	2593.17	0.00230447	0.00877282	0.011077	1	1	2
High current rocky shore	1.69	0	0	0			
High current shallow gravel	453.98	0.036726929	0.1539993	0.190726	1	1	2
High current shallow reef	144.15	0.641731929	0.702869762	1.344602	1	1	2
High current shallow sand	459.17	0.216693929	1.135673361	1.352367	1	1	2
Moderate beach	11.32	0	0	0			
Moderate rocky shore	3.26	0	0	0			
Moderate shallow gravel	1031.37	0	0	0			
Moderate shallow reef	130.42	0	0	0			
Moderate shallow sand	700.62	0	0	0			
Mudflat	85.02	0	7.995483527	7.995484		2	2
Shallow mud	172.88	0	0	0			
Sheltered beach	0.70	0	0	0			
Sheltered rocky shore	0.08	0	0	0			
Sheltered shallow gravel	0.95	0	0	0			
Sheltered shallow reef	7.95	0	0	0			
Sheltered shallow sand	24.80	0	0	0			
Upper slope	2194.54	0	0	0			

Table 16. East Coast South Island

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Biogenic saltmarsh	0.071162095	0		0			
Biogenic saltmarsh above MHW	0.022835183	0		0			
Biogenic seagrass	0.141958807	0		0			
Deep gravel	511.6869882	0		0			
Deep mud	2017.791216	0.004514107		0.004514	1		1
Deep reef	20.20495822	0		0			
Deep sand	2121.438182	0.026701626		0.026702	2		2
Estuarine	0.000755986	0		0			
Estuarine beach	0.451789454	0		0			
Estuarine mud	73.09011965	0		0			
Estuarine reef	12.52356413	5.617055037		5.617055	2		2
Estuarine rocky shore	0.370991291	0		0			
Estuarine sand	22.791366	11.27231465		11.27231	2		2
Exposed beach	1.383458872	0		0			
Exposed rocky shore	0.239005924	0		0			
Exposed shallow gravel	61.30476068	0		0			
Exposed shallow reef	31.86530849	5.987824583		5.987825	2		2
Exposed shallow sand	646.1276453	0.18438469		0.184385	2		2
High current deep gravel	42.72165552	0		0			
High current deep mud	309.4246623	0		0			
High current deep reef	0.794479283	0		0			
High current deep sand	699.5756989	0		0			
High current rocky shore	0.020563815	0		0			
High current shallow mud	2.317531214	0		0			

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
High current shallow reef	7.508757704	0		0			
High current shallow sand	88.85745468	0.478390995		0.478391	1		1
Lower slope	326.9022461	10.48814706		10.48815	1		1
Mid slope	456.4738877	7.454540363		7.45454	1		1
Moderate beach	180.658424	0		0			
Moderate rocky shore	3.633921881	1.143045171		1.143045	1		1
Moderate shallow gravel	526.9809975	0		0			
Moderate shallow reef	121.0241094	0.613600487		0.6136	1		1
Moderate shallow sand	1230.941919	0.050639656		0.05064	1		1
Mudflat	14.68604624	0		0			
Shallow mud	723.2668882	0		0			
Sheltered beach	1.662441152	0		0			
Sheltered rocky shore	0.000112992	0		0			
Sheltered shallow gravel	13.35065104	0		0			
Sheltered shallow reef	26.62490869	0		0			
Sheltered shallow sand	447.9695595	0		0			
Upper slope	331.2196264	10.17826995		10.17827	1		1

Table 17. Kermadec Islands

Note: For this bioregion, the percentage of all habitats in a marine reserve or type 2 MPA was set at 100%. Minor errors in these calculations are mainly due to misalignment between mapped classifications and mapped marine reserve boundaries.

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Deep reef	22.80	100		100	1		1
Deep volcanic	345.69	100		100	1		1
Lower slope	2750.64	100		100	1		1
Mid slope	3000.39	100		100	1		1
Upper slope	942.00	100		100	1		1
Exposed shallow reef	16.54	100		100	1		1
Exposed shallow volcanic	29.79	100		100	1		1
Moderate shallow reef	5.64	100		100	1		1
Moderate shallow volcanic	25.99	100		100	1		1
Exposed rocky shore	0.87	100		100	1		1
Moderate rocky shore	0.65	100		100	1		1

Table 18. Subantarctic Islands

Note: For this bioregion, the percentage of all habitats in a marine reserve or type 2 MPA was set at 100%. Minor errors in these calculations are mainly due to misalignment between mapped classifications and mapped marine reserve boundaries.

Habitat	Representativity				Replication		
	Area of habitat in bioregion (km^2)	% in marine reserves	% in type 2 MPAs	Total % in MPAs	Marine reserves	Type 2 MPAs	Total MPAs
Deep gravel	5758.37	65.64392	34.3223	100	4	2	6
Deep reef	9.43	92.25875	7.780625	100	4	1	5
Estuarine gravel	78.92	99.50583	0	100	2		2
Estuarine reef	40.84	99.43683	0	100	2		2
Exposed rocky shore	2.86	96.85315	0	100	4		4
Exposed shallow gravel	358.36	99.85769	0	100	3		3
Exposed shallow reef	29.54	97.63033	0	100	4		4
Moderate shallow gravel	106.49	99.8967	0	100	3		3
Moderate shallow reef	30.65	99.90212	0	100	3		3
Upper slope	1645.10	75.36685	24.63336	100	4	2	6
Deep mud	553.64	100	0	100	3		3
Estuarine	0.01	100	0	100	1		1
Estuarine beach	0.01	100	0	100	1		1
Estuarine rocky shore	1.53	100	0	100	1		1
Lower slope	1459.64	100	0	100	2		2
Mid slope	1270.08	100	0	100	2		2
Moderate beach	0.11	100	0	100	1		1
Moderate rocky shore	1.39	99.28058	0	100	2		2
Deep sand	493.51	78.4665	21.43143	100	1	1	2
Exposed shallow sand	3.83	99.7389	0	100	1		1

Figure 17. Map of benthic protection areas (BPAs) and closed seamounts in New Zealand's EEZ. Note that all BPAs that extend into the territorial sea overlap with marine reserves or have some fishing restrictions in order to be considered type 2 MPAs.

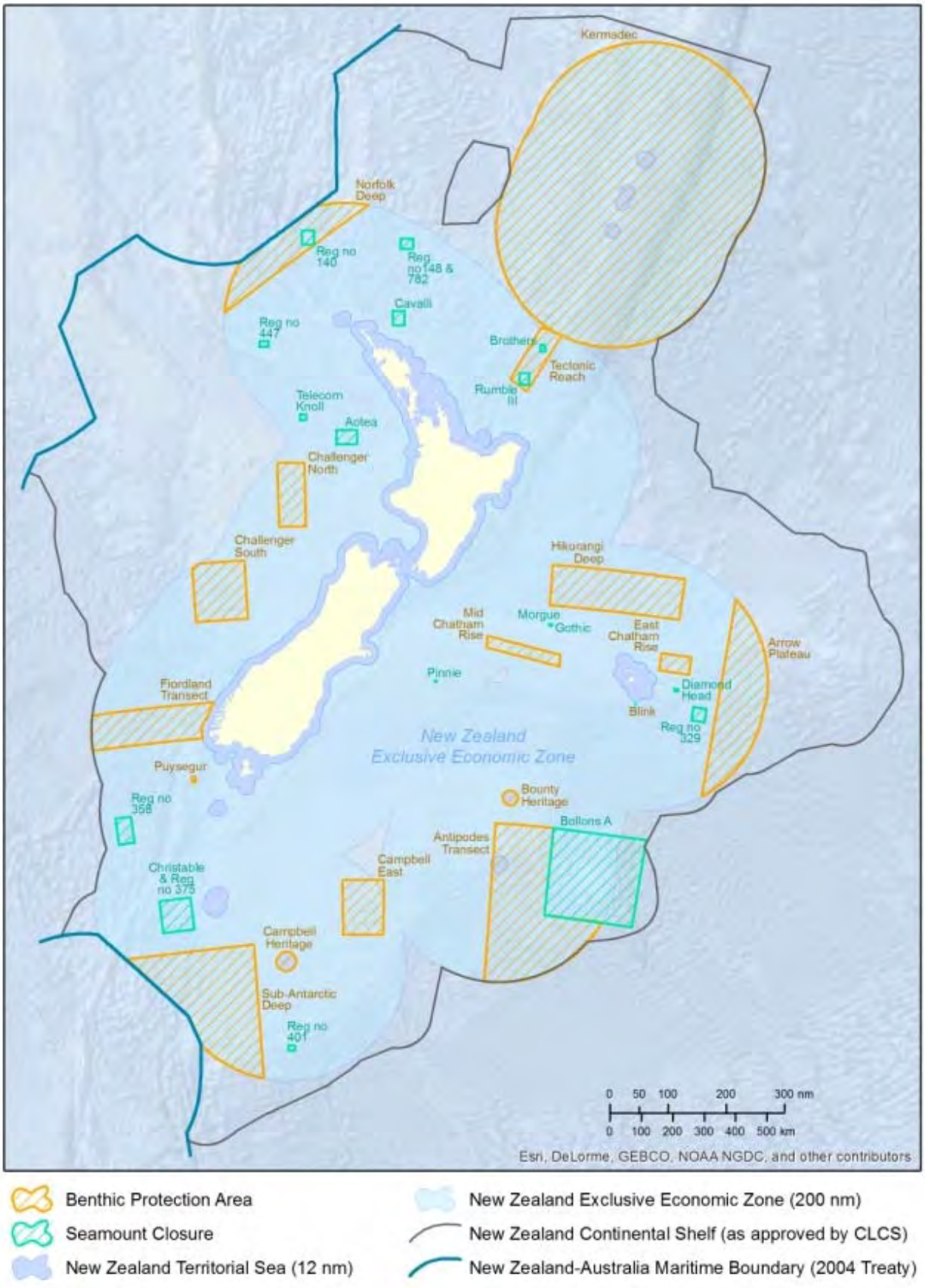

Figure 18: Map of marine mammal sanctuaries around mainland New Zealand.

Figure 19. Map of government purpose reserves, existing marine reserves and wildlife sanctuaries within 15 km of the coast (North Island).

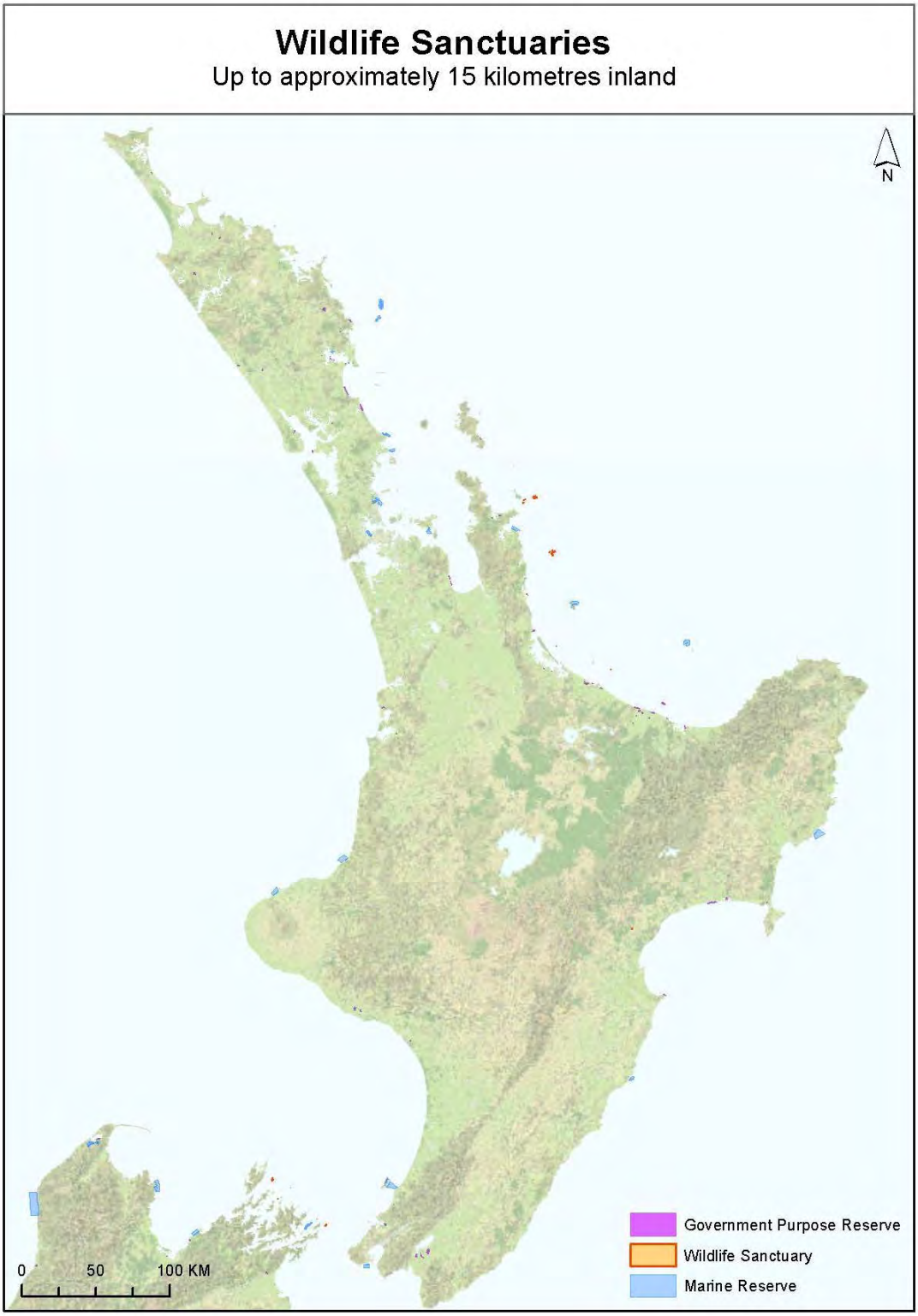

Figure 20. Map of government purpose reserves, existing marine reserves and wildlife sanctuaries within 15 km of the coast (South Island).