

Sites of significance for indigenous marine biodiversity in the Wellington Region – 2021 update

Prepared for Greater Wellington Regional Council

December 2020 (Revised November 2021)



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NIWA CLIENT REPORT No: 2020351WN
Report date: December 2020
NIWA Project: WRC20307

Quality Assurance Statement		
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Cover photo: Giant kelp, *Macrocystis pyrifera* at Kau Point (Wellington Harbour) Image courtesy of Nicole Miller.

Recommended citation

Nelson, W.A., Bowden, D., D'Archino, R., MacDiarmid, A., Mountjoy, J., Peart, R., Rowden, A., Watson, S. (2021) Sites of significance for indigenous marine biodiversity in the Wellington Region – 2021 update. *NIWA Client Report 2020351WN*.

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Executive summary

Under the Resource Management Act 1991 (RMA), Greater Wellington Regional Council (GWRC) has primary responsibility for managing aquatic biodiversity in the Wellington Region, including within the coastal marine area (CMA), which extends from mean high water spring to 12 nautical miles offshore and includes estuaries and harbours. In 2012 NIWA prepared a report for GWRC that identified: the key rare and diverse sites for biodiversity in the CMA, and the present and future activities that could impact these sites; representative examples of the habitat types that occur in the CMA and are worthy of protection; and, areas that are important as migration routes for sea birds and marine mammals or supply/dispersal routes for marine invertebrates and fish, including a description of existing and future activities that threaten the species using these areas (MacDiarmid et al. 2012a). These sites and habitats all meet criteria for having significant indigenous biodiversity values set out in Policy 23 of the Regional Policy Statement for the Wellington Region (RPS) and Policy 11 of the New Zealand Coastal Policy Statement (NZCPS) (Table 1.1).

A workshop was convened by NIWA in July 2020 to update the 2012 report on the basis of more recent information. Further new sites of significance were identified in 2021, and a survey conducted of the *Adamsiella* beds in Evans Bay in mid-2021 (D'Archino et al. 2021). This survey also identified the presence of horse mussels in Evans Bay.

This report provides a desktop update of the 2012 report including:

- New information for four sites of significance already listed in PNRP Schedule F4 (sites with significant indigenous biodiversity in the coastal marine area):
 - Evans Bay *Adamsiella* algal beds
 - Kāpiti Island rhodolith beds
 - Cook Strait shelf-edge canyons
 - Opuawe Bank methane seeps.
- New information for three existing habitats of significance already listed in PNRP Schedule F5 (habitats with significant indigenous biodiversity in the coastal marine area):
 - Kelp bed habitat on exposed rocky sub-tidal reefs
 - Giant kelp (*Macrocystis*) beds
 - Deep sea wood-fall/*Xyloplax* (sea daisy) habitat.
- Three new sites assessed as meeting the RPS/NZCPS significance criteria, being:
 - Kāpiti Island anemone meadows
 - Horse mussels in Evans Bay
 - Mataikona Reef seagrass
 - Outer Cook Strait seamounts

One of the sites, the Kāpiti Island rhodolith beds, lies at least partly inside the Kāpiti Marine Reserve, and is protected from trawl related impacts. Exposed rocky reef habitat and kelp beds are partly protected within the western and eastern marine reserves around Kāpiti Island and within the Taputeranga Marine Reserve along Wellington's south coast, although they may still be affected by poor water quality and climate change impacts. All other sites and habitats are currently unprotected, two other areas protect a small proportion of the sites and habitats from a number of impacts: the narrow exclusion zone around the Cook Strait Cable Protection Zone (CPZ) (https://data-gwrc.opendata.arcgis.com/datasets/749f7cc694394b58a84eea28034f77fd_18 |), and the weapons dumping zone in the eastern Cook Strait (within a 5 nautical mile radius of 41° 44'S 175° 01'E, one of five sites in New Zealand waters used for ammunition disposal).

This report does not include new data about the site "Mataikona mixed algal assemblages" or the habitats "Subtidal Reef habitat" and "Wellington Habitat Corridors" that were treated by MacDiarmid et al. (2012a).

The identified sites and habitats are threatened by a range of human activities, as well as global and local climate impacts. Those sites and habitats nearest to land are typically threatened by a greater number of activities, and many of these result from activities within catchments or from activities such as dredging or spoil dumping that are under the direct jurisdiction of GWRC. However, some of the more pressing threats to deepwater habitats, such as the methane seeps on Opouawe Bank off the south-eastern Wairarapa coast and one of the seamounts in the outer Cook Strait, are from the effects of bottom trawling. In these instances, GWRC will need to work with the Ministry for Primary Industries to effect protection.

The sites and habitats identified as containing significant marine biodiversity are located in either shallow coastal areas or deep-water areas. Only two habitats occur in part on the shelf, the Opouawe Bank and the outer Cook Strait seamounts. This reflects our poor knowledge of shelf ecosystems in the Wellington Region and isn't necessarily a true reflection of important marine habitats within this zone. The sites and habitats identified as containing significant marine biodiversity in the Wellington Region vary widely in the amount of information available to define their habitat features relevant to the biodiversity evaluation criteria; many of the sites and habitats are poorly known.

Focused investigations at these locations or habitats are likely to reveal much relevant information, and there is a need to collect baseline data and institute monitoring in order to evaluate the status and any changes in these sites and habitats.

Adamsiella beds: the areal extent of the beds in Evans Bay was surveyed in mid-2021 (D'Archino et al. 2021). In addition to delimiting the bed, the 2021 survey enabled some data to be collected on the epifauna and infauna associated with the beds. It is not known whether there are seasonal fluctuations in the size and composition of macroalgae making up the assemblage within the bed, nor if there are seasonal changes in the associated fauna. In addition, further work is needed to better understand the ecosystem services provided by this habitat. The beds and the component species appear to be particularly vulnerable to impacts of sedimentation (particularly associated with activities in and around Evans Bay), but further work is needed to fully understand the impacts of human-induced modifications and climate change.

Horse mussels: horse mussel beds have been located in the southern end of Evans Bay and around Kapiti Island. The Evans Bay bed has had some initial mapping, but the full extent of both this bed has yet to be determined, and the Kapiti Island bed has not been surveyed. Given the biodiversity

reported to be associated with horse mussels, and their roles as ecosystem engineers, the response of horse mussels and their associated biota to human-induced changes needs investigation, in particular to establish whether there needs to be further protection or mitigation of any current practices or activities that may be having deleterious impacts.

Rhodolith beds: The distribution and density of the rhodolith beds at Kāpiti remain to be documented, as well as the associated biota, to establish whether these beds are serving as biodiversity hotspots as has been postulated. The response of the rhodoliths and their associated biota to human-induced changes also needs investigation, in particular to establish whether there needs to be further protection or mitigation of any current practices or activities that may be having deleterious impacts.

Anemone beds: Investigations are needed to understand the distribution and density of the anemone beds, and associated biota. Given such assemblages have not been documented previously in the New Zealand region research on their ecology, phenology and physiology, particularly in relation to key climate change stressors is warranted.

Mataikona seagrass: Although there have been reports of these patches for ca 50 years, the distribution and extent of these beds is undocumented. It is not known if these seagrass areas vary seasonally or inter-annually and the degree of connectivity between patches. Impacts of local stressors need to be evaluated (such as local sources of sedimentation and impacts of roading, etc), as well as general impacts related to climate change (e.g. temperature impacts, frequency and intensity of storm events).

Shelf edge canyons and Methane seeps: For both of these sites, impacts associated with fishing, particularly bottom trawling, are currently the main threat to seafloor fauna. Summaries of fishing effort for trawling, set netting and long lining within the relevant portions of the CMA would enable a clearer picture of activities that have occurred historically and are currently underway and provide context for decisions about protection measures.

Outer Cook Strait seamounts: As for the above sites, an update of the bottom trawling footprint would assist in providing a better appreciation of the potential fishing impacts facing these seamounts. The faunal communities of the deeper seamount are relatively well documented, however, no sampling has taken place on the shallow seamount with its peak in the photic zone. This seamount represents a rare habitat in the CMA and in New Zealand EEZ, and could support a particularly diverse and abundant mixed community of algae and invertebrates. This seamount is currently fished by recreational fishers, but nothing is known about the quantities of catch or the potential effects of this type of fishing pressure on the biotic communities.

Kelp Habitats and *Macrocystis* beds: The international evidence strongly points to the vulnerability of habitat-forming large brown algae to changing climate, particularly changes in temperature (both increases in mean temperature and heat waves). Kelps are also vulnerable to indirect impacts of fishing and interactions of predators and herbivores. There are limited baseline data about the extent of *Macrocystis* in the Wellington region as well as the other major habitat-forming species, and there is a need for research on their vulnerability within the Wellington region to the key local and global stressors. The research using machine learning for surveying kelp beds including observations of seasonal and interannual changes, that has been initiated by D'Archino et al. (2019,2020), offers potential as a cost-effective tool for monitoring and evaluation of change. The

acquisition of baseline data will enable evidence-based management and potentially enable mitigation of local stressors.

Table 1-1: Scheduled sites and how they meet the NZCCPS vs RPS criteria. Red text denotes habitats with significant indigenous biodiversity values, the locations of which have not been fully determined.

NZCPS Policy 11	RPS Policy 23	Representativeness	Rarity	Diversity	Ecological context
a	i.	<i>Adamsiella</i> beds; Horse mussel beds; Rhodolith beds; Anemone meadows; Mataikona seagrass; Shelf edge canyons; Methane seeps; Wellington Harbour freshwater seeps; Porirua Harbour (Pauatahanui Inlet); Kelp beds; Outer Cook Strait seamounts Giant kelp beds (<i>Macrocystis</i>)	<i>Adamsiella</i> beds; Horse mussel beds; Rhodolith beds; Anemone meadows; Mataikona seagrass; Methane seeps; Deep sea wood-fall; Wellington Harbour freshwater seeps; Porirua Harbour (Pauatahanui Inlet); Giant kelp beds (<i>Macrocystis</i>); Outer Cook Strait seamounts	Shelf edge canyons; Methane seeps; Porirua Harbour (Pauatahanui Inlet); Giant kelp beds (<i>Macrocystis</i>); Outer Cook Strait seamounts	
	ii.				
	iii.				
	iv.				
	v.				
	vi.				
b	i.			Mataikona mixed algal assemblages; Rhodolith beds; Horse mussel; kelp beds; Giant kelp (<i>Macrocystis</i>)	Giant kelp beds (<i>Macrocystis</i>); Porirua Harbour (Pauatahanui Inlet)
	ii.				
	iii.				
	iv.				
	v.				
	vi.				

1 Introduction

Under the Resource Management Act 1991 (RMA), Greater Wellington Regional Council (GWRC) has primary responsibility for managing aquatic biodiversity in the Wellington Region, including within the coastal marine area (CMA), which extends from mean high water springs to 12 nautical miles (NM) offshore and includes estuaries and harbours. Two key policies in GWRC's Regional Policy Statement for the Wellington Region (RPS, GWRC 2013- <http://www.gw.govt.nz/rps/>) address the sustainable management of indigenous biodiversity in the CMA:

- Policy 22 which directs regional and district plans to identify ecosystems and habitats with *significant indigenous biodiversity values*; and
- Policy 23 which establishes the criteria for identification of significant indigenous biodiversity values – being representativeness, rarity, diversity, ecological context, and tangata whenua values.

Sites and habitats with significant indigenous biodiversity values in Wellington's CMA are listed in Schedules F4 and F5 of GWRC's Proposed Natural Resources Regional Plan for the Wellington Region (PNRP, GWRC 2019 - <http://pnrp.gw.govt.nz/home/decisions/>):

- Schedule F4 – Sites with significant indigenous biodiversity values in the CMA (these sites are mapped as polygons on GWRC's GIS web map viewer); and
- Schedule F5 – Habitats with significant indigenous biodiversity values in the CMA (these habitats have not been mapped to their full extent, but their known locations are described in the Schedule).

Activities (e.g., discharge of contaminants, reclamation) occurring in sites and habitats identified in Schedules F4 and F5 are managed by stronger policies and more restrictive rules than those that apply to activities carried out in other areas.

The sites and habitats listed in Schedules F4 and F5 are drawn directly from two reports: a report prepared by the Department of Conservation (DOC) listing the locations and social and ecological values of all the estuaries in the lower North Island (Todd et al. 2016) and, a report prepared by the National Institute of Water and Atmospheric Research Limited (NIWA) listing coastal and offshore marine sites and habitats of significance in the Wellington Region (MacDiarmid et al. 2012a). The 2012 NIWA report identified:

- the key rare and diverse sites for biodiversity in the Wellington Region's coastal marine environment, and the present and future activities that could impact these sites;
- representative examples of the habitat types that occur in the Wellington CMA (including deep water) worthy of protection; and
- the coastal waters that are important as migration routes for sea birds and marine mammals or supply/dispersal routes for marine invertebrates and fish, and the existing and future activities that threaten the species using these areas.

Forty-one sites and eleven habitats of significant biodiversity were identified in the CMA within the Wellington Region, ranging from the shallow Te Arawa-o-Porirua Harbour to methane seeps lying in 1,100 m of water on Opouawe Bank off the south-eastern Wairarapa coast.

In March 2020, recognising that the base information used to develop Schedules F4 and F5 is now eight years old, GWRC commissioned NIWA to prepare a brief technical report identifying updated information of relevance. In addition, GWRC sought a review of the activities and pressures that negatively impact these sites and habitats so that relevant policies can be refined or developed. Examples of this include consideration of the effects of climate change (e.g., Foley & Carbines 2019) which were not adequately considered in the first iteration of these schedules, and the effects of fisheries on indigenous biodiversity, an activity that regional councils are now able to consider under the RMA.

1.1 Scope

This report represents a supplementary report to MacDiarmid et al. (2012a) and seeks to:

1. Identify new (i.e., additional) sites and habitats that meet GWRC's RPS Policy 23 / NZCPS Policy 11¹ criteria for significant indigenous biodiversity, where sufficient information is available to describe and locate these;
2. Describe the attributes and values of each site or habitat, including commentary regarding any value for climate change mitigation;
3. Identify the current state (based on expert opinion), activities and pressures that negatively impact these sites and habitats (including consideration of the effects of fisheries use and management and vulnerability to the effects of climate change); and
4. Prioritise additional sites or habitat types for further investigation.

This report is based solely on a desktop collation and assessment exercise utilising existing datasets, information and expert opinion. No new data gathering, modelling or complex analysis were sought by GWRC.

1.2 Report outline

This report comprises three main sections.

- Section 2 provides an outline of the methodology used to prepare this report as well as an overview of predicted climate change impacts in the Wellington Region.
- Section 3 presents new information about eight sites of significance for marine biodiversity.
- Section 4 presents new information about three habitats of significance for marine biodiversity.

¹ Policy 11 of the New Zealand Coastal Policy Statement (NZCPS 2010) relates to the protection of indigenous biological diversity in the coastal environment and includes requirements to avoid adverse effects of activities on specific types of ecosystems, habitats and species.

2 Methods

Three steps were agreed with GWRC to identify sites and habitats of significant ecological value within the CMA of the Wellington Region:

1. Collation of available data;
2. Workshop with staff from NIWA, the Department of Conservation (DOC) and GWRC to discuss the quality and relevance of data and classification of each site; and
3. Finalisation of site-specific assessments and production of deliverables.

2.1 Collation of relevant information

Sites of significant ecological value were identified using a variety of data and information that describe features of the marine ecosystems in the Wellington Region. As noted in the 2012 report prepared by MacDiarmid et al., varying amounts of information were available for different sites and habitats. Some sites were well supported by quantitative survey data while other sites had a greater reliance on qualitative or inferential (modelled) data. Some habitats within the region are particularly poorly sampled. We have flagged where more data may be required to adequately define, characterise and assess particular sites/habitats for future inclusion in GWRC's PNRP.

2.2 Workshop with NIWA, DOC and GWRC staff

A workshop was held in July 2020 attended by Megan Oliver (GWRC/DOC), Pam Guest (GWRC), Megan Melidonis (GWRC), Helen Kettles (DOC), and Alison MacDiarmid, Wendy Nelson and Ashley Rowden (NIWA).

Data on sites and/or habitats in the Wellington Region that had been identified as possibly meeting the RPS/NZCPS significance criteria were discussed, as well as new information about sites/habitats that had already been identified in the 2012 report.

Following the workshop GWRC identified that this supplementary report cover:

- new data available from multibeam survey and habitat mapping at Kāpiti Island;
- updating information about rhodolith beds and the discovery of anemone beds;
- new multibeam data available for Cook Strait, including the generation of new figures and updated descriptions in particular in reference to canyons and methane seeps;
- new data on macroalgal beds including meadows, kelp and specifically *Macrocystis*;
- intertidal seagrass patches on the Wairarapa coast; and
- minor changes to the 2012 report text on deep-sea Xyloplacidae (sea daisies).

Following the workshop, it was also agreed that this supplementary report would include information on two seamount features in the outer Cook Strait. It had not been previously realised that these features were within the area of responsibility of GWRC. In addition, survey work on the *Adamsiella* bed in Evans Bay was conducted in mid-2021, and new information about this site resulting from that survey is included here. In the course of the *Adamsiella* survey, horse mussels were found in Evans Bay and information about this site of significance is also reported here.

2.3 Reference

- D'Archino, R., Nelson, W.A., Neill, K.F., Pallentin, A. (2021) Characterisation of the Evans Bay *Adamsiella* algal bed. Prepared for Greater Wellington Regional Council. *NIWA Client Report* 2021306WN.
- MacDiarmid, A., Nelson, W., Gordon, D., Bowden, D., Mountjoy, J., Lamarche, G. (2012a) Sites of significance for indigenous marine biodiversity in the Wellington region. Prepared for Greater Wellington Regional Council. *NIWA Client Report* WLG2012-19: 85.

3 Sites of significance for marine biodiversity

3.1 Soft sediment *Adamsiella* algal beds in Wellington Harbour

3.1.1 Description

Meadows of the red algae *Adamsiella* spp. attached to small shells or pebbles occur over substantial areas of muddy sediment at the southern end of Evans Bay, Wellington Harbour (Figure 3-1). These meadows were discovered during routine biosecurity surveys of yachts and motor launches in the Evans Bay marina (Inglis et al. 2006) where 2-minute dredge tows at 2 knots were often found to be full of this species (Kate Neill, NIWA, personal comment). In 2019, as part of investigations to evaluate the potential ecological impact of metropolitan Wellington's proposed water supply pipeline to be constructed on the bed of Wellington Harbour, in a survey carried out by Cawthron Institute, the position of the red-algal bed was recorded but not the area occupied (Morrisey et al. 2019). The algal beds were detected in the western and southern parts of Evans Bay using drop-video camera at c. 140 locations in Evans Bay. *Adamsiella angustifolia* was the dominant species identified, however an assessment of the biodiversity associated with the bed has not been carried out.

A targeted survey of the *Adamsiella* bed was conducted in May/June 2021, to document its extent, associated biodiversity (both macroalgae and large invertebrates), as well as identifying anthropogenic and climate change threats to this red algal meadow (D'Archino et al. 2021). The *Adamsiella* bed is in the south west corner of Evans Bay between depths of ca. 4-8 m and is adjacent to a marina, Evans Bay Parade and Cobham Drive (State Highway One) (Figure 3-2). The *Adamsiella* bed was delimited and mapped using towed video transects in May 2021. Diver surveys were conducted in June 2021 using a stratified sampling design in areas of dense, sparse and no *Adamsiella*, enabling the extent of the bed to be further evaluated, along with an assessment of the associated diversity and biomass of the *Adamsiella*.

The total area of the *Adamsiella* bed was estimated to be 114,735 m² (11.4735 ha), consisting of 65,192m² of dense beds (100% cover) and 49,543m² with less dense coverage of *Adamsiella*. The accumulations of *Adamsiella* in dense regions ranged from ca. 10-15 cm in thickness. The estimates of the biomass per square metre in the dense and sparse *Adamsiella* bed were respectively 2582 g and 515 g wet weight.

Collections from dive transects resulted in a total of 60 taxa (1 fish, 39 invertebrates and 20 algae). Species richness was lowest in the transect with no *Adamsiella* cover (mean 3.6 taxa) and ranged between an average of 7.6 and 10 taxa in the transects with dense *Adamsiella* cover. Molluscs were the most abundant invertebrate group in the dense transects, making up 67 to 86% of the number of invertebrates found.



Figure 3-1: *Adamsiella* meadow and some of the associated species in Evans Bay. Photo: P. Marriott, NIWA.



Figure 3-2: Presence of *Adamsiella* beds in Evans Bay (based on D'Archino et al. 2021).

3.1.2 Biodiversity values

General values:

Macroalgae are known to be important structural and functional components of marine ecosystems, contributing through provision of products of photosynthesis, as well as providing structure and surfaces for other organisms to attach to. Their function in soft sediment ecosystems has received little attention in New Zealand: based on recent research in other New Zealand harbours it is likely that the macroalgal biodiversity has been significantly under-reported and is poorly documented. The assessment of the macroalgae associated with soft sediment habitat in Whangarei, Otago and Kaipara harbours detected 146, 150 and 43 taxa respectively, collectively representing approximately 30% of the currently recognised New Zealand macroalgal flora (Neill et al. 2012; Nelson & Neill 2016).

In other areas of New Zealand, *Adamsiella* beds are known to support a range of associated species (Rainer 1981; Hare 1992; Anderson et al. 2019). On Stewart Island, Roper et al. (1988) concluded that the *Adamsiella* meadows in Big Glory Bay “probably play an important role in stabilising the muddy bottom and provide a refuge for animals”. *Adamsiella* beds occur in several locations in the Marlborough Sounds and have been reported to be associated with bivalves, including horse mussels and scallops, holothurians, tube worm colonies, and fish (Davidson et al. 2010, 2015; Anderson et al. 2019, 2020). In Otago Harbour maximum growth of the meadow-forming *Adamsiella chauvini* (Harv.) L.E. Phillips & W.A. Nelson occurred between January and March (Kregting et al. 2008a, b). After examining the nutrient status of this alga and the prevailing nutrient environment within the harbour, Kregting et al. (2008a, b) proposed that macroalgae growing on soft sediments may have little reliance on external nutrients but rather obtain sufficient nutrients from localised sources from sediments beneath the macroalgal canopy.

The recent research on Mediterranean red algal meadows has revealed high associated biodiversity of invertebrates with Rossbach et al. (2021) recommending that these habitats “should be included in conservation strategies”. Schmidt et al. (2021) note the need to further investigate how red algal mats may be moderating local environmental conditions, and to evaluate the potential of red algal mats to serve as refuge habitat for organisms “which may suffer habitat loss from anthropogenic pressure and climate change”.

Site specific values:

There has been very limited information about the soft sediment environments within the Wellington Region in terms of macroalgae (Adams 1972; Nelson 2008). The 2021 winter survey to delimit the *Adamsiella* bed revealed it to be a site with high biomass when compared to both soft sediment algal assemblages and other marine algal habitats in New Zealand (e.g. Desmond et al. 2015; Neill & Nelson 2016).

3.1.3 Habitat features relevant to criteria

Representativeness: – Macroalgae on soft sediments are poorly protected within the Wellington Region with few such habitats occurring within existing marine reserves.

Rarity: – Algal assemblages on soft sediments are rare regionally, probably only occurring in Wellington and Te Awarua-o-Porirua Harbours but there is a lack of systematic data on regional and national distribution.

Diversity: – *Adamsiella* beds support a range of associated species (D’Archino et al. 2021). Seasonal fluctuations in the assemblage – in terms of biomass and composition of the biota – has not yet been evaluated, nor detailed analyses of ecological functioning.

Ecological context: – Algal assemblages are primary producers, stabilise sediments, and provide habitat and food for fish and invertebrates.

3.1.4 Threats – present and future

These beds are likely to be currently experience the impacts of invasive species, boat anchoring, sedimentation and pollution (e.g., road runoff, stormwater and wastewater overflow inputs). Recent work on the seawall at the southern end of Evans Bay has resulted in significant sedimentation and reduced visibility with resuspended material under stormy conditions. Anderson et al. (2019) summarised the key stressors and threats influencing algal meadows at a national scale. The threats of greatest relevance to the *Adamsiella* bed in Evans Bay include the impacts of sedimentation, boat anchoring, pollution, marina expansion, reclamation, invasive species, and general effects of climate change. The most significant impacts of climate change are likely to be rising sea water temperatures (both long term and also associated with heat waves), sedimentation and nutrients, with extreme rainfall, ocean acidification and sea level rise, all evaluated as having moderate impact.

3.1.5 Existing status and levels of protection

As noted by Anderson et al. (2019) algal meadows on soft sediments are poorly protected in New Zealand with few occurring within existing marine reserves. In addition, little is known about the vulnerability or recovery rates of algal meadows relative to stressors and disturbances.

In terms of the Wellington region, algal assemblages on soft sediments are rare regionally, and no red algal meadows occur within existing marine reserves. Consideration of the values of these beds and their protection should be considered if future development of the marina or Evans Bay is proposed.

3.1.6 Site relevant references

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3.2 Horse Mussel beds

Horse mussels, *Atrina zelandica* (Gray, 1835), New Zealand horse mussels, have been located at the southern end of Evans Bay and in the vicinity of the Kapiti Marine Reserve. These are common pinnid bivalve molluscs found around New Zealand in coastal waters. The common name 'horse mussel' can refer to a number different species across the world. In New Zealand the records refer to *Atrina zelandica*. Recent molecular phylogenetic studies have indicated that even though this family is well documented there is evidence that a number of members of this family may also be cryptic species complexes (Lemer et al. 2014).

New Zealand horse mussels are large, narrow fan shaped bivalves growing up to 30 cm in length. They live in soft or sandy sediments, embedded with narrow end in the sediment with approximately 10cm projecting above the sediment (Cummings et al. 1998). They are shallow water species extending down to approximately 50 m depth and occurring around New Zealand's coastline. There is very little information about the lifespan of the bivalves. It is known that horse mussels are broadcast spawners, then grow rapidly for 2 – 4 years after settlement, after this initial period the growth rates reduce significantly (Hayward et al. 1997). The information that is available indicates that the large shells can be anywhere between 5 and 15 years of age.

Horse mussels can form dense beds which create biogenic habitats, supporting a variety of other invertebrates such as solitary and colonial ascidians, barnacles, encrusting sponges, encrusting bryozoans, polychaete worms such as serpulids and spirorbids, encrusting coralline algae, gastropods and other bivalves, small crustaceans such as amphipods and isopods, and even sometimes small vertebrates (fish) feed on the accumulated detritus and nutrients between shells (Hayward et al. 1997; Cummings et al. 1998) and of course the pea-crab, *Nepinnotheres* spp. living between the valves of the mussel.

Horse mussel beds are important in changing sediment flow and structure/roughness on the seabed (Green et al. 1998; Gibbs et al. 2005; Nikora et al. 2002). Despite this structural capability, they are vulnerable to sudden chemical, physical and biological events (such as storms, heavy metal runoff and developments – Hayward et al. 1998; Hewitt & Pilditch 2004).



Figure 3-3: Horse Mussels in situ in Evans Bay from survey conducted in May 2021 (D'Archino et al. 2021).



Figure 3-4: Distribution of horse mussels in Evans Bay from survey conducted in May 2021 (D’Archino et al. 2021).

3.2.1 Biodiversity values

General values:

Horse mussel beds typically support a large and diverse number of organisms that rely on the protection and food resource and nutrient flux supplied by the shells themselves and the excretions of the mussels. (Cummings et al. 1998; Fisheries report 2008). The organisms themselves are only considered as a bycatch of other fisheries, not as a commercial fishery themselves. However, an official quota for this species was established in 2004 (Fisheries report 2008).

Site specific values:

Horse mussel populations have been documented and characterised all around New Zealand, however a complete characterisation of both the Kāpiti Island Reserve and Evans Bay populations has not been undertaken, so the full physical extent and abundance of these mussel beds remains unknown. This is the first attempt at characterisation.

3.2.2 Habitat features relevant to criteria

Representativeness: – Both the Evans Bay and the Kāpiti horse mussel beds are typical of shallow beds elsewhere in New Zealand in terms of depths and environmental conditions (substrate, water motion).

Rarity: – Although horse mussels are recorded from a variety of places around New Zealand from Northland to Stewart Island, there are limited records from the Wellington Region.

Diversity: – These organisms provide a protected environment for a large suite of organisms, however more detailed characterisation needs to be done.

Ecological context: – There have been numerous studies into the dynamics of nitrogen and oxygen flux associated with the waste products produced from horse mussel beds (Hewitt et al. 2006). Changes caused by sedimentation and seafloor structure produced by these beds also alters the neighbouring environments and ecosystems (e.g. when related species of mussels were removed neighbouring seagrass beds decline in health and size – Macreadie et al. 2014), and also how these organisms are affected by changes in the sediment load (Ellis et al. 2002)

3.2.3 Threats – present and future

Horse mussel beds qualify as habitats of particular significance due to their associated biodiversity, and their roles as ecosystem engineers, and their vulnerability to disturbance. The long-term effect of fishing and harvesting for horse mussels on the functioning of the natural marine habitat and ecosystems is unknown, however, they have been shown to be vulnerable to the impacts of a range of human activities, including physical disruption from trawling, dredging, and anchoring (Hayward et al. 1998) as well as from deterioration in water quality. Their presence can cause alterations to water movement, and so care needs to be taken when disturbance takes place.

Studies have noted that there is evidence that natural storm disturbance and water conditions can cause sudden die-off of the mussels (Hayward et al. 1997; Cummings et al. 1998; Hewitt & Pilditch 2004) so it is expected that as the climate changes due to anthropogenic causes including changes in temperature gradients and increase in storm events, that there would be increases in the vulnerability of these organisms and associated communities.

3.2.4 Existing status and levels of protection

An unknown proportion of the horse mussel beds falls within the Kāpiti Marine Reserve where they are completely protected from exploitation and direct human disturbance. The beds outside the reserve currently have no protected status. Given the probable biological continuity and simultaneous patchiness (due to broadcast spawning) and biodiverse habitat it would seem appropriate to address ecological connectivity and incorporate the beds within protection measures.

Those occurring in Evans Bay, while not covered by existing protection would also need to be considered as vulnerable.

3.2.5 Site relevant references

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3.3 Kāpiti Island rhodolith beds

In April 2015 Victoria University of Wellington (VUW), DOC, Land Information New Zealand (LINZ), and NIWA agreed through a Memorandum of Understanding (MoU) to jointly fund the mapping of a portion of the seafloor surrounding Kāpiti Island. Data collected by the Kāpiti Mapping Group are being analysed in a variety of ways, including as the basis of post-graduate research studies at VUW. Preliminary information from this work is reported here, including new data on the rhodolith beds in the vicinity of Kāpiti Island, and also the discovery of extensive anemone beds (Figure 3-3, Figure 3-4) (Pallentin et al. 2016).

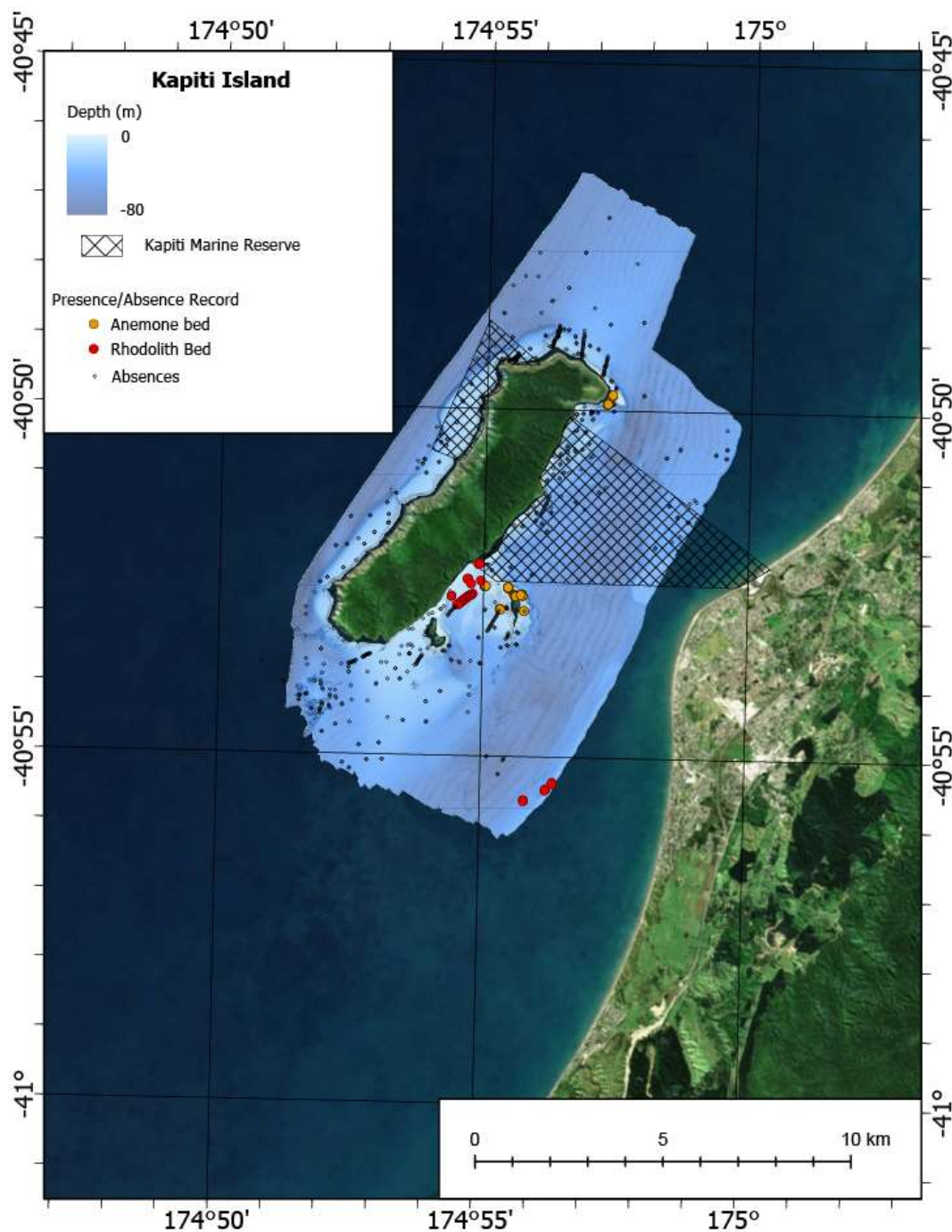


Figure 3-5: Map showing boundaries of the Kāpiti Marine Reserve and the presence/absence of rhodoliths and anemones based on the surveys conducted by the Kāpiti Mapping Group (DOC, LINZ, NIWA and VUW).

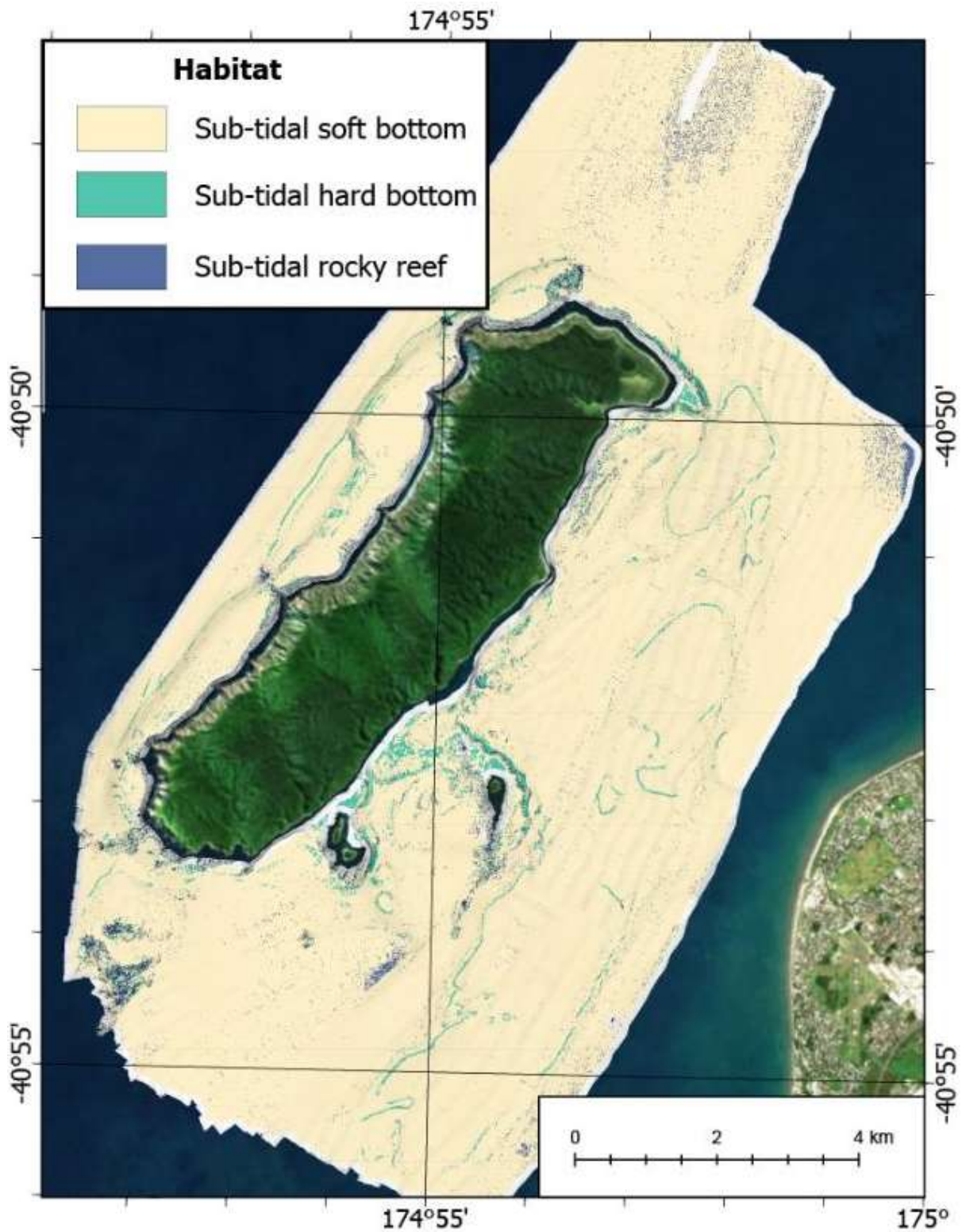


Figure 3-6: Map showing benthic habitat classification (Devaux 2019) across the surveyed area around Kāpiti Island.

3.3.1 Site relevant references

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3.3.2 Rhodolith beds

Rhodoliths (or maerl) are a free-living growth form of non-geniculate (unjointed, usually crustose) coralline algae and are not attached to any fixed substrate (Figure 3-5). They can be moved around on the sea floor by water motion and exhibit a range of morphologies including smooth, warty, and delicate branching forms. Rhodoliths often form extensive beds on the sea floor (e.g., Amado-Filho et al. 2012) and the complex morphology of rhodoliths provides a very heterogeneous habitat supporting many rare and unusual species. As reported in MacDiarmid et al. (2012a) opportunistic collections have revealed the presence of rarely collected isopods (e.g. *Mexicope sushara*, previously only known from the SE South I.), bryozoans (e.g. "*Schizoporella*" *spectabilis*, only record outside Foveaux Strait, southern South I.; *Celleporaria* sp. nov.; *Celleporaria agglutinans*; *Parasmittina delicatula*).

The branching or rounded thalli collectively create a fragile, structured biogenic matrix over coarse or fine carbonate sediment providing refugia for juvenile fish and complex habitat for the settlement of shellfish larvae. Internationally, rhodolith beds have been identified as critically important biodiversity hotspots, harbouring high diversity and abundance of marine animals and algae in comparison with surrounding habitats. Rhodolith beds have also been identified as important nursery areas for commercial species such as scallops, crabs, and fish, and are home to high densities of broodstock bivalves (Nelson 2009).



Figure 3-7: Examples of rhodoliths collected from the Kāpiti area.

Rhodoliths have been shown to act as an endolithic reservoir and seed bank for many microalgal species living within their structure, such as ecologically important dinoflagellates (Krayesky-Self et al. 2017; Fredericq et al. 2019). These contributions of rhodoliths have not been examined in New Zealand to date.

As yet there is little information about the location, extent or ecosystem functioning of rhodolith beds in New Zealand (summarised in Nelson & Neill 2017). Studies on rhodoliths and rhodolith beds have been conducted in northern New Zealand (Nelson et al. 2012, 2014; Neill et al. 2015), but there have been no detailed published investigations of the rhodoliths at Kāpiti Island to date.

Kāpiti Island is the largest island off the west coast of the North Island, approximately 50 km north of Wellington and 5 km offshore. In April 1992 the Kāpiti Marine reserve was gazetted and formally established in May 1992. Kāpiti Island has been a focus of marine recreational activities such as fishing (including commercial fishing) and diving. In a baseline survey of the marine habitats and communities of Kāpiti Island, Battershill et al. (1993) reported on rhodolith beds to the east of the Island:

“At 200 m offshore [20-25 m depth], a rhodolith bed is encountered... Rhodoliths were very dense in patches of the bed and layered to over 25 cm deep. The bed extended over 200 m due east. The eastern limit was not found, nor were the northern and southern extensions of the bed (extended over 200 m north and south of Station 9).”

3.3.3 Biodiversity values

General values:

Rhodolith beds typically support an unusual suite of organisms that rely on the three-dimensional space provided. Around the world, rhodolith beds have been documented as biodiversity hotspots (Riosmena-Rodriguez et al. 2017).

Site specific values:

The Kāpiti Island rhodolith beds are the only beds known from the lower North Island. Complete characterisation of the Kāpiti Island rhodolith beds has not been undertaken – so the full physical extent and abundance of rhodoliths remains unknown, and there have been no surveys of the associated flora and fauna.

3.3.4 Habitat features relevant to criteria

Representativeness: – The Kāpiti rhodolith beds are typical of shallow beds elsewhere in the world in terms of depths and environmental conditions (substrate, water motion).

Rarity: – The only known site with rhodoliths in the Wellington Region.

Diversity: – The opportunistic invertebrate collections available to date give a glimpse of the potential diversity associated with these beds, but surveys and documentation remain to be carried out.

Ecological context: – Detailed investigations of ecological functions have yet to be conducted.

3.3.5 Threats – present and future

MacDiarmid et al. (2013) identified rhodolith beds as being sensitive biogenic marine habitats in New Zealand. Lundquist et al. (2017) reviewed the contributions made by small natural features (SNFs) – ecosystems that ‘support a diverse fauna and flora and provide ecosystem services disproportionate to their size’ – a category which applies to rhodolith beds.

Rhodoliths have been shown to be vulnerable to the impacts of a range of human activities, including physical disruption from trawling, dredging, and anchoring (Hall-Spencer & Moore 2000), as well as from deterioration in water quality (e.g., Wilson et al. 2004; Riul et al. 2008), alterations to water movement through marine engineering, and aquaculture installations such as shellfish rafts and lines and fish cages (Hall-Spencer et al. 2003, 2006). Rhodoliths are considered to be particularly vulnerable given their fragility and slow growth rates (0.05–2 mm/yr) (e.g., Wilson et al. 2004). Fragmentation from physical disruptions has significant impacts on the communities associated with rhodolith beds. For example, Steller et al. (2003) found that the diversity and abundance of species associated with rhodoliths increase as the complexity (branching density) and the space available (thallus volume) within the bed increases.

Along with other calcified macroalgae, rhodoliths will experience impacts from ocean acidification (OA) resulting from global climate change. It is anticipated that OA will primarily result in a reduction in net calcification rates and growth, and responses are likely to be both species-specific and habitat-dependent. For example, slower seawater velocities allow corallines to exert a greater influence on the surrounding pH (summarised in Law et al. 2017; Nelson et al. 2019).

3.3.6 Existing status and levels of protection

An unknown proportion of the rhodolith beds falls within the eastern portion of the Kāpiti Marine Reserve where they are completely protected from exploitation and direct human disturbance. The beds outside the reserve currently have no protected status. Given the probable biological continuity of this fragile and biodiverse habitat it would seem appropriate to address ecological connectivity and incorporate the beds within protection measures.

3.3.7 Site relevant references

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3.4 Kāpiti Island anemone beds

3.4.1 Description

During the mapping of the Kāpiti coastal marine area the anemone *Anthothoe albocincta* was found forming beds in excess of hundreds of square metres. This species grows to a maximum diameter of 30 mm, possesses many tentacles, and varies in colour, although it can usually be distinguished by its orange or green oral disc with distinct, short, white stripes on the column.

Anthothoe albocincta is one of the most commonly encountered anemones in shallow water (from the intertidal zone to 20 m depth) around New Zealand and it is also found in Australia. It feeds on food captured from the water column and can reproduce asexually by clonal budding, which can result in local populations of large numbers of cloned individuals.

Research has investigated the potential role of *A. albocincta* in control of non-indigenous species of ascidians and bryozoans (e.g. the bryozoan *Bugula neritina*) (Atalah et al. 2013).

3.4.2 Biodiversity values

Research is currently underway on these beds based on the results of the survey conducted by the Kāpiti Mapping Group.

3.4.3 Habitat features relevant to criteria

Representativeness & Rarity: – No other anemone beds are known within the New Zealand region that are equivalent to the ones reported from Kāpiti Island.

Diversity & Ecological context: – Research on the ecological functions within these assemblages have yet to be conducted, although research elsewhere has shown the association of anemones with biogenic substrates and potential vulnerability to climate change-associated ecosystem disturbances (e.g. Watson et al. 2018).

3.4.4 Threats

Threats faced by the anemone beds are similar to those for the Kāpiti rhodolith beds. The anemone beds are likely to be vulnerable to the impacts of a range of human activities, including physical disruption from trawling, dredging, and anchoring. Steinberg et al. (2020) in a review of threats to anemones globally also lists collection and trade, disease, predation, pollution, and climate change as potential threats. They also note that resilience or susceptibility within this large group is likely to be site and species specific and that the loss of anemones has been difficult to quantify as most species have no hard structures that remain following a mortality event. Only through long-term monitoring will changes in these populations be able to be documented.

3.4.5 Existing status and levels of protection

None. Given the rarity of assemblages of anemones in New Zealand waters, consideration of protection for these beds is warranted.

3.4.6 Site relevant references

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WoRMS website:<http://www.marinespecies.org/aphia.php?p=taxdetails&id=291759>

3.5 Mataikona Reef seagrass

3.5.1 Description

The Mataikona reefs extend about 8 km along the north-eastern Wairarapa Coast between Whakataki and Mataikona. They are comprised of alternating bands of hard and softer sedimentary rock that have been tilted 90° so that the layers sit vertically. The softer layers have been eroded away forming channels between the harder layers that emerge like long rows of spines (Figure 3-6a).



Figure 3-8a (left): Alternating channels and 'spines' of emergent harder rock at Mataikona. Image (a): H. Nelson.

Figure 3-8b (right): Intertidal *Zostera* beds on Mataikona reefs Image (b): W. Nelson.

These unusual, visually dramatic reefs extend into subtidal waters. The highly dissected and extensive reef platforms along the Mataikona coast provide a wide range of habitats and support particularly diverse shallow reef communities and rich algal flora (Adams 1972). In places, intertidal patches of the sea grass *Zostera muelleri* are found on fine silty sand on the reef platforms (Adams 1972, Figure 3-6b).

Seagrass grows through the lateral extension of rhizomes and the upward growth of individual blades, with the main mode of growth being clonal rather than through flowering and seed production. Seagrass provides a biogenic habitat function for many species, although associated biodiversity varies from the intertidal to subtidal. Seagrass meadows are defined as areas of continuous/dominant (>60%) plant cover within an area of 10,000 m² or more, with areas smaller than this referred to as seagrass patches (Anderson et al. 2019).

The full extent and distribution of these seagrass patches on the Wairarapa Coast have not been surveyed and it is also not known whether there are any patches or beds in the subtidal along this coast.

3.5.2 Habitat features relevant to criteria

Representativeness: – The Mataikona seagrass patches are occupying habitats typical for these species.

Rarity: – These are the only known open coast intertidal seagrass patches in the Wellington Region.

Diversity: – There have been no investigations of the diversity associated with these seagrass patches.

Ecological context: – No detailed investigations of ecological functions have been conducted.

3.5.3 Threats – present and future

The key threats are land-based issues such as increased suspended sediments and sedimentation and associated reductions in water column light levels, preventing adequate light reaching seagrass blades (Anderson et al. 2019). Coastal development and vehicles on foreshores are also threats for intertidal seagrass assemblages, as are climate change impacts such as sea level rise, increased water temperature, and turbidity (Anderson et al. 2019). Oliver and Milne (2012) noted that in the eastern Wairarapa the hill country areas are characterised by large areas of soft erosion-prone soils and the soil lost from pastoral and bare land contribute to high sediment loads in rivers draining to the coast.

MacDiarmid et al. (2012b) identified 47 threats facing intertidal reefs on exposed coasts. They were assessed as being extremely vulnerable to increased storminess, as well as impacts deriving from increased intertidal water and air temperatures, ocean acidification, increased sea temperature, sea level rise, sedimentation, change in currents, and increase in ultraviolet (UV) light. Seven of the top ten threats to intertidal reef habitat related to the global threat of climate change, another was associated with human activities in catchments (sedimentation), while others related to activities in the marine environment and a mixture of catchment and marine based activities.

Although located in a remote part of the Wellington Region, the public road from Whakataki to Mataikona provides easy access to the rock platforms and so exploitation of reef species is potentially higher for these reefs than most other reefs on the Wairarapa Coast.

The reefs are bounded to the north and south by the Mataikona and Whakataki rivers, respectively, that provide a ready conduit for sediments to impact on this reef system. Management of land use patterns in the upstream catchments is thus important in reducing this threat.

3.5.4 Existing status and levels of protection

Seagrass is not well represented in marine reserves or protected areas in the Wellington Region, populations of both subtidal and intertidal seagrass are scattered and infrequent, and these specific patches are not protected.

3.5.5 Site relevant references

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3.6 Shelf edge canyons

3.6.1 Description

Submarine canyons are narrow valleys cut into the continental shelf and slope, usually having steep rocky walls, sometimes near vertical or overhung. They are found along most continental slopes around the world being more frequent on landmasses with active margins. New Zealand has at least 72 canyons (De Leo et al. 2010) but most lie in the Exclusive Economic Zone (EEZ) outside the Territorial Sea. Shelf incising canyons that occur within the 12 NM limit are only found in the Wellington, Canterbury and South Westland regions.

Seven canyons occur partly within the territorial waters of the Wellington Region (Figure 3-7). From east to west these are Honeycomb, Pahaua, Opouawe, Palliser, Wairarapa, Nicholson and Cook Strait Canyon. The northern wall of the Cook Strait Canyon lies only partly within the Wellington Region. Palliser, Wairarapa and Nicholson Canyons can be considered major branches of Cook Strait Canyon that runs over 100 km in length from 120 m water depth on the shelf to 2,700 m in the Hikurangi Trough (Mountjoy et al. 2009).

Nicholson Canyon lies within ~10 kilometres of Wellington City and can be considered part of Wellington's seascape in much the same way as the Remutaka Range is considered part of metropolitan Wellington's landscape. Wairarapa Canyon runs within 2-3 km of the land adjacent to the Remutaka Forest Park, forming an enormous range within the space of just a few kilometres, from forested mountain peaks to submarine canyons.

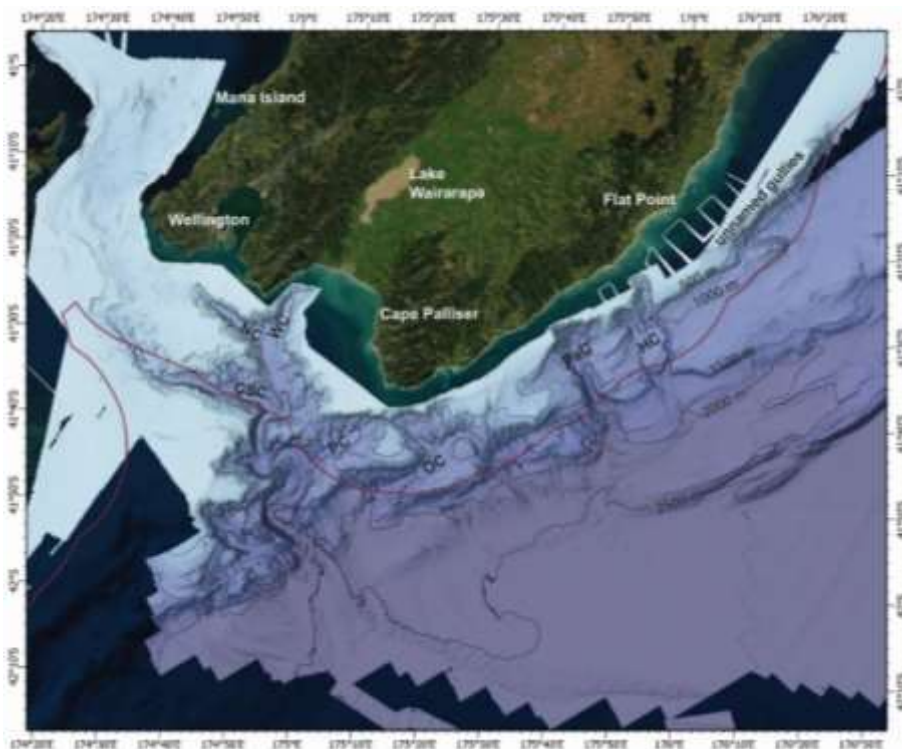


Figure 3-9: Location of canyons within the territorial waters of the Wellington Region. Light blue to purple coloured seafloor indicates the coverage of multibeam bathymetric data. 500 m depth contours are shown. The seaward limit of the New Zealand territorial sea is defined by the purple line. Abbreviated canyon names from east to west are HC Honeycomb Canyon, PaC Pahaua Canyon, OC Opouawe Canyon, PC Palliser Canyon, WC Wairarapa Canyon, NC Nicholson Canyon, CSC Cook Strait Canyon. The Cook Strait Canyon system includes PC, WC, NC and CSC as these all combine into one canyon axis.

For the purposes of habitat analysis, Lamarche et al. (2012) recognised seven geomorphic domains within the Cook Strait region that give an indication of the different seafloor landscape environments; continental shelf, angular gullies, smoothed gullies, canyon walls, canyon floor, bank crests, continental slope and trough. Excluding the continental shelf, slope and trough areas; over half of the canyon areas were made up of smoothed gullies (30%) and canyon walls (27%). Canyon floors (21%), angular gullies (16%) and bank crests (6%) formed the remainder (based on areas provided in Table 53.1 in Lamarche et al. 2012).

3.6.2 Biodiversity values

General values:

As canyons contain a variety of distinct habitats, the associated fauna is usually very different from adjacent shelf and slope habitats. For example, steep rocky canyon walls often support corals and other specialised filter feeders that otherwise are uncommon on the adjacent sediment flats on the shelf and slope (e.g., Iacono et al. 2012). Moreover, canyons are often sites of enhanced flux of organic matter through channelling of coastal and terrestrial detritus, down-welling of dense shelf waters, upwelling of cold nutrient rich waters, and sediment deposition that in some canyons may sustain biomasses and levels of production far greater than in adjacent habitats of similar depth (De Leo et al. 2010). The 2016 Kaikōura Earthquake demonstrated unequivocally that the canyons in the Southern Hikurangi Margin can pass significant volumes of sediment through them during large earthquakes (Mountjoy et al. 2018). Kaikōura Canyon experienced by far the largest event, flushing out an estimated 1 km³ of sediment, resulting in large-scale changes to canyon geomorphology and almost complete removal of the high biomass existing in the canyon floor sediments. Several canyons in the Wellington Region (the Cook Strait Canyon system, Opouawe Canyon and Pahaoa Canyon) passed smaller amounts of sediment through the lower canyon axis (Howarth et al. in press). The impact of these smaller events on canyon geomorphology and ecosystems is unknown. The large-scale changes in the Kaikōura Canyon provide an example of what could happen in the Wellington Region canyons during a large local earthquake.

Site specific values:

Lamarche et al. (2012) summarised the existing biological knowledge of the benthos of the Cook Strait Canyon system. Although over 100 faunal samples and tens of seafloor images were obtained (Figure 3-8), these were collected in an ad hoc manner for a variety of reasons over more than three decades, and consequently limited the extent of formal analysis of benthic communities. Nonetheless different faunal assemblages were identified in association with the seven geomorphic habitat features occurring in the canyon system (Table 3-1).

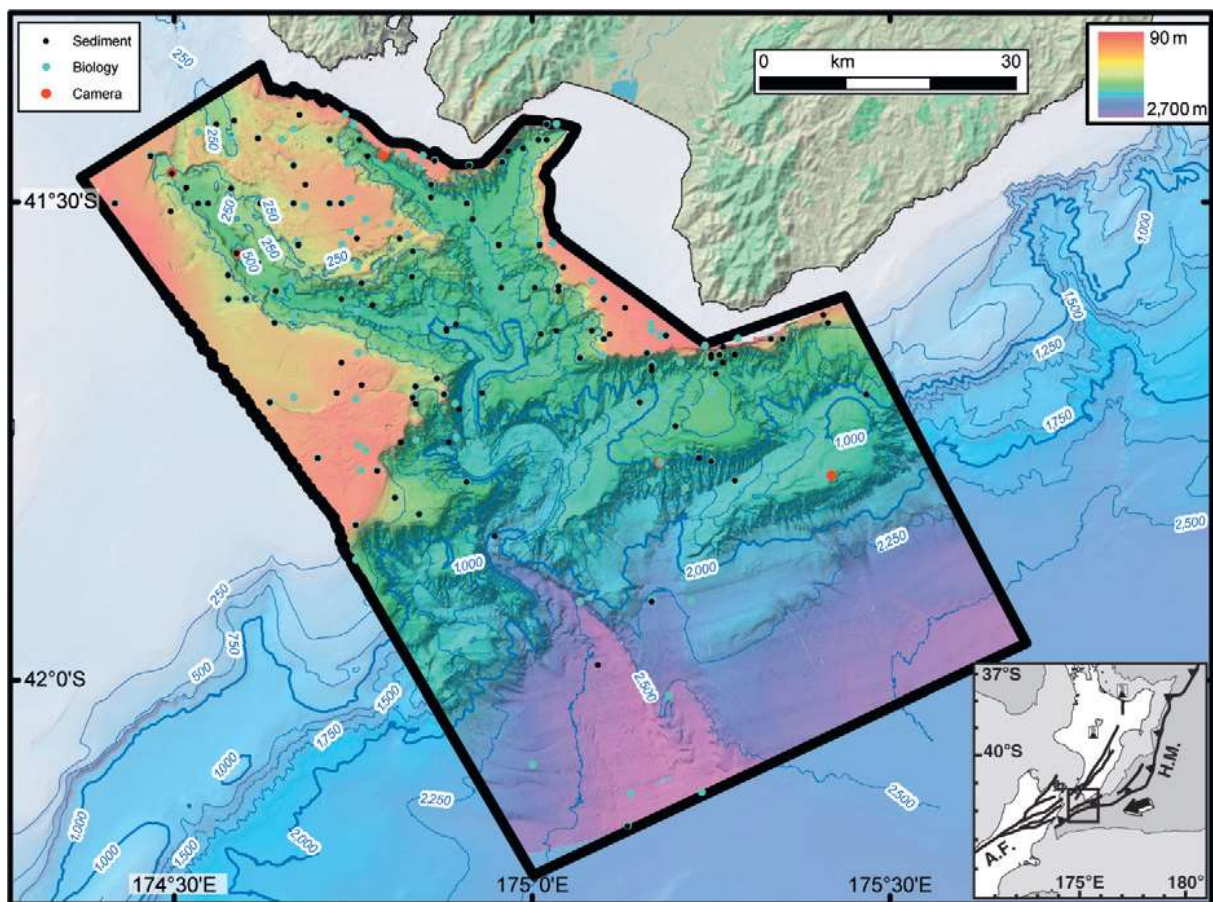


Figure 3-10: Cook Strait Canyon systems. The location of sediment and biological sample collection points, and camera stations are shown. From Lamarche et al. (2012).

Despite the inconsistent levels of taxonomic identification among the samples from the different geomorphic habitats, a preliminary estimate of taxon richness was made based on presence/absence at the faunal family level (Table 3-1). Taxon richness was found to be lowest for the two most disturbed habitats, angular and smooth gullies, and the canyon walls affected by mass failure. Taxon richness was estimated to be highest for the bank crests (including the cold seeps) and the continental slope. Soft sediments of the canyon floor and shelf had intermediate levels of taxon richness. This analysis approach has not been applied beyond the Cook Strait Canyon system.

Sampling outside of the area of the Cook Strait Canyon system (Figure 3-8) but within the CMA, took place as part of a NIWA study to assess the relative vulnerability of benthic communities of different deep-sea habitats along the Hikurangi Margin and the Bay of Plenty. Within the CMA of the Wellington Region, the Pahaua and Honeycomb canyons, as well as adjacent slope areas, and a seamount, were sampled for benthic meio-, macro- and megafauna and mega-epifauna between depths of 700 and 1,500 m. This study found that megafaunal communities in the canyons were significantly different from those of the slope and seamount, with most of the dissimilarity between habitats resulting from a number of taxa being more abundant or present only at canyon habitats compared to the other two habitats (e.g., burrowing fauna such as urchins, peanut worms, and holothurians) (Rowden et al. 2016). Macro-infaunal communities were only different between canyons and slope, with more suspension feeders and predators found in canyons (Leduc et al. 2016). For mega-epifauna and meiofauna, differences in community structure among canyons, slope and/or seamount habitats on the Hikurangi Margin were much less pronounced or not apparent

(Bowden et al. 2016, Rosli et al. 2016). Analyses for this study included data from methane seeps on the Opouawe Bank, and benthic communities at this habitat, for all size groups, were distinct from those at canyon, slope and seamount habitats on the Hikurangi Margin (see section 3.6).

Fish faunas associated with New Zealand canyons are less well known. Certain species occur in very high abundance within the Cook Strait Canyon system. For example, a very significant fishery is based on the winter spawning aggregations of hoki (*Macruronus novaezelandiae*) in Cook Strait Canyon. Demersal fish habitat modelling by Leathwick et al. (2006) suggests that particularly high species richness is associated with the Cook Strait Canyon system, but the rather coarse spatial scale used cannot resolve within-canyon habitat distributions. However, Californian studies suggest that canyon fish fauna may discriminate based on depth and substratum (Yoklavich & Greene 2012).

DOC and Cawthron records (see Beaumont et al. 2008) indicate that many whale and dolphin species occurring in New Zealand have been sighted in the vicinity of the canyon systems in Cook Strait. These include blue whales (*Balaenoptera musculus*), minke whales (*Balaenoptera acutorostrata*), humpback whales (*Megaptera novaeangliae*), southern right whales (*Eubalaena australis*), sperm whales (*Physeter macrocephalus*), pilot whales (*Globicephala melas* and *G. macrorhynchus*), killer whales (*Orcinus orca*), bottlenose dolphins (*Tursiops truncatus*), dusky dolphins (*Lagenorhynchus obscurus*), and common dolphins (*Delphinus sp.*). Some of these species, especially the larger baleen whales, may be in transit between northern calving and breeding grounds and Southern Ocean feeding grounds, while the toothed whales and dolphins probably find prey in the surface waters over the canyons or within the canyons themselves.

Similarly, Bartle (1974) has described the seabird fauna of eastern Cook Strait, which includes the surface waters over the canyons. Bartle described an inshore belt extending from the coast to eight kilometres offshore, that is characterised by the presence of fluttering shearwaters and diving petrels with little blue penguins (*Eudyptula minor*), gulls, terns and gannets (*Morus serrator*) almost entirely confined to this part of Cook Strait with little overlap with the adjacent canyon system in Cook Strait. Bartle (1974) also described an offshore belt, which extends further than eight kilometres offshore, characterised by fairy prions (*Pachyptila turtur*) and sooty shearwaters (*Puffinus griseus*). The large albatrosses, mollymawks and petrels are largely confined to this area, which overlaps with the canyon system in Cook Strait. Buller's shearwaters (*Puffinus bulleri*) occur throughout both zones.

Table 3-1: Benthic faunal assemblages and number of taxa found at seven different geomorphic habitats in the Cook Strait Canyon system. Descriptions and data sourced from Lamarche et al. (2012).

Geomorphic habitat	Associated faunal assemblage	Number of taxa
Continental shelf	Decapod crustaceans are conspicuous members of this assemblage, particularly majid crabs and pagurid hermit crabs. Asteroids (sea stars) and ophiuroids (snake stars) also occur frequently. Pecten bivalves and buccinid gastropods are among the reasonably well represented mollusc taxa. Polychaetes and other burrowing fauna such as sipunculids and small bivalve species occur in the soft sediments.	67
Angular and smoothed gullies	Echinoids (sea urchins) are the dominant echinoderms of the angular gullies, with at least five species. Asteroids and ophiuroids also occur. Mollusc representatives such as bivalves and gastropods occur frequently in these gullies. Filter feeders such as sponges, brachiopods, and scleractinian corals (e.g., <i>Caryophyllia profunda</i> and <i>Flabellum apertum</i>) are found attached to exposed rock. Few samples have been obtained from the smoothed gullies, but assemblages appear to be similar to that described above.	27, 14
Canyon walls	On exposed hard substrates occur at least four species of scleractinian corals, as well as other filter feeders such as sponges, ascidians, hydrozoans, brachiopods, and bryozoans. Decapod crustaceans occur relatively frequently, in particular galatheid squat lobsters. Serolid isopods also occur among the crustacean fauna. Soft sediment fauna also occur in places within this general habitat, including polychaetes, echinoids and bivalves.	42
Canyon floor	This sandy habitat appears to have sparse fauna, i.e., relatively few taxa in low frequency of occurrence among samples. However, the few samples and seafloor images obtained from this habitat show that ophiuroids can occur in high abundances. Among the more common fauna are some small-sized crustaceans such as amphipods (belonging to the Lysianassidae family) and isopods (Serolidae and Cirolanidae), as well as decapods. Pycnogonids (sea spiders) are also reasonably well represented. Burrowing polychaetes, echinoids, and bivalves occur in canyon floor substrates	25
Bank crests	This assemblage appears to be taxon rich. A number of cold seeps are located on the Opouawe Bank (see section 3.6), characterized by carbonate structures and a particular seep fauna, either associated with the biogenic substrate or the soft sediment surrounding these features. Over 20 species of polychaete have been sampled, including members of Siboglinidae typically found at chemosynthetic habitats such as seeps. Other seep-associated taxa are found among the frequently occurring bivalve mollusc fauna. Corals, sponges, actinarians, and hydrozoans are among the fauna found attached to the carbonate structures at the seep sites. Decapod crustaceans, ophiuroid and holothurian echinoderms, and gastropod molluscs occur among the “background” assemblage of the bank crest habitat.	82
Continental slope and Hikurangi Trough	On the continental slope area many different taxonomic groups occur, but no particular faunal group or species dominates. The decapod crustaceans are represented by species of majids, galatheids, pagurids, and pasiphaeids. Echinoid, ophiuroid, and asteroid echinoderms also occur. Among the mollusc groups, which include the gastropods and scaphopods, the bivalves are particularly well represented by at least 11 species. The latter include epi- as well as infaunal species (belonging to the orders Nuculoidea and Veneroida). Some fauna associated with hard substrates, such as sponges, gorgonian and scleractinian corals, and hydrozoans, are also found on the continental slope. Only one sample has been obtained from the Hikurangi Trough adjacent to the Cook Strait Canyon; it contained an unidentified polychaete and bivalve.	34

3.6.3 Habitat features relevant to criteria

Representativeness: – The Cook Strait Canyon system contains habitats and species poorly represented in existing protected areas. The two marine reserves in the Wellington Region are both located in shallow water reaching depths of less than 50 m and few, if any, of the benthic species occurring in these reserves overlap with those in canyon habitats.

Rarity: – Canyon habitats and associated biological communities are rare within New Zealand territorial seas existing only within the Wellington (seven canyons), Canterbury (Kaikōura Canyon) and South Westland regions. New Zealand is particularly rich in shelf edge canyons with 72 identified to date (De Leo et al. 2010) but these occur well outside territorial waters. Two of the Wellington Region canyons are rare and unusual on a global scale. As noted earlier in this section, Nicholson Canyon lies within close proximity to Wellington City and can be considered part of Wellington’s seascape, while Wairarapa Canyon runs within 2-3 km of land adjacent to protected mountain forest habitat (Remutaka Forest Park). Thus, within the space of just a few kilometres, the environment spans an enormous range from forested mountain peaks to submarine canyons.

Diversity: – Because of their evolution and structure, shelf edge canyons have a diversity of geomorphic habitat types ranging from rocky vertical rock walls, angular and smoothed gullies, canyon floors and in some places bank crests, as well as the shelf and slope features into which they are incised. Each of these habitats can have distinct assemblages of benthic organisms (Rowden et al. 2016). The distribution and diversity of demersal and pelagic fish within the different canyon habitats is less well known in New Zealand but based on Californian studies distribution may be affected by depth and substratum (Yoklavich & Greene 2012).

Ecological context: – the Cook Strait Canyon system provides important breeding habitat for hoki that gather from a wide area of the east coast of both the North and South Islands and the Chatham Rise and spawn in this locality each winter (Ministry of Fisheries 2011). The broader Cook Strait region is an important migration corridor for numerous species of fish, marine mammals and seabirds.

3.6.4 Threats present and future

Unintended consequences of bottom trawling and dredging are currently the main threat to seafloor fauna in canyon habitats. Summaries of fishing effort for trawling, set netting and long lining in the southern portion of the CMA have been summarised in MacDiarmid et al. (2015) and reveal areas where activities have been particularly intense (e.g. near the head of the Wairarapa Canyon).

Unquantified threats may exist related to terrestrial contaminant sources (e.g., the close proximity of the Nicholson Canyon to Wellington and Hutt cities with associated discharges of wastewater and stormwater to the CMA; runoff from farmland draining into the Wairarapa Canyon).

Emerging threats identified by MacDiarmid et al. (2012b) include acidification, increases in sea temperature and other consequences of increasing levels of greenhouse gases in the atmosphere.

3.6.5 Existing status and levels of protection

None. Fishing activities and fish stocks are currently managed under existing fisheries legislation and regulations. At present there is little protection of representative deeper marine habitats in the coastal region, and there is not integrated protection that enables a “mountains to seafloor” approach that recognises continuity between terrestrial and marine environments. The geomorphic

habitats summarised here, along with their associated biota, are both regionally and nationally diverse and distinctive, and thus warrant consideration for protection.

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3.7 Opouawe Bank methane seeps

3.7.1 Description

Methane seeps, also known as cold seeps, are seabed sites where methane-rich fluid escapes into the water column through gas hydrate layers in the underlying sediment. Gas hydrates trap methane molecules in water ice under specific conditions of pressure and temperature in the gas hydrate stability zone (Pecher & Henrys 2003). In temperate latitudes, these conditions typically occur in water depths of at least 500 m, and down to 500 m beneath the sediment surface, with reservoirs of free gas often trapped below the stability zone. Rupture of the gas hydrate stability zone, for instance by geological faulting, may result in free gas reaching the seafloor, forming methane seeps. Methane seeps have been documented widely in the northern hemisphere (e.g., North Sea, Baltic Sea, Black Sea, North Atlantic, Gulf of Mexico, north-west Pacific, Indian Ocean; Judd & Hovland 2007; Suess 2010).

Methane seep sites are of particular ecological interest because the availability of methane in high concentrations supports seabed communities of highly specialised chemoautotroph bacterial and invertebrate organisms that depend on chemosynthetic, as opposed to photosynthetic, energy pathways, with many taxa being wholly or partially dependent on symbioses with methanotrophic or thiotrophic bacteria (Levin 2005). In New Zealand, research voyages from 2006 to 2019 have confirmed that the Hikurangi Margin off the east coast of the North Island is a major gas hydrate province encompassing numerous sites of intense methane seepage, most of which support associated chemoautotrophic faunal communities (Baco et al. 2010; Greinert et al. 2010; Bowden et al. 2013; Watson et al. 2019) (Figure 3-9). Carbonate is a by-product of chemoautotrophic activity and extensive carbonate rock formations on the seabed, and on the adjacent land, indicate that methane seeps have been active on this margin over geological timescales (Greinert et al. 2010).

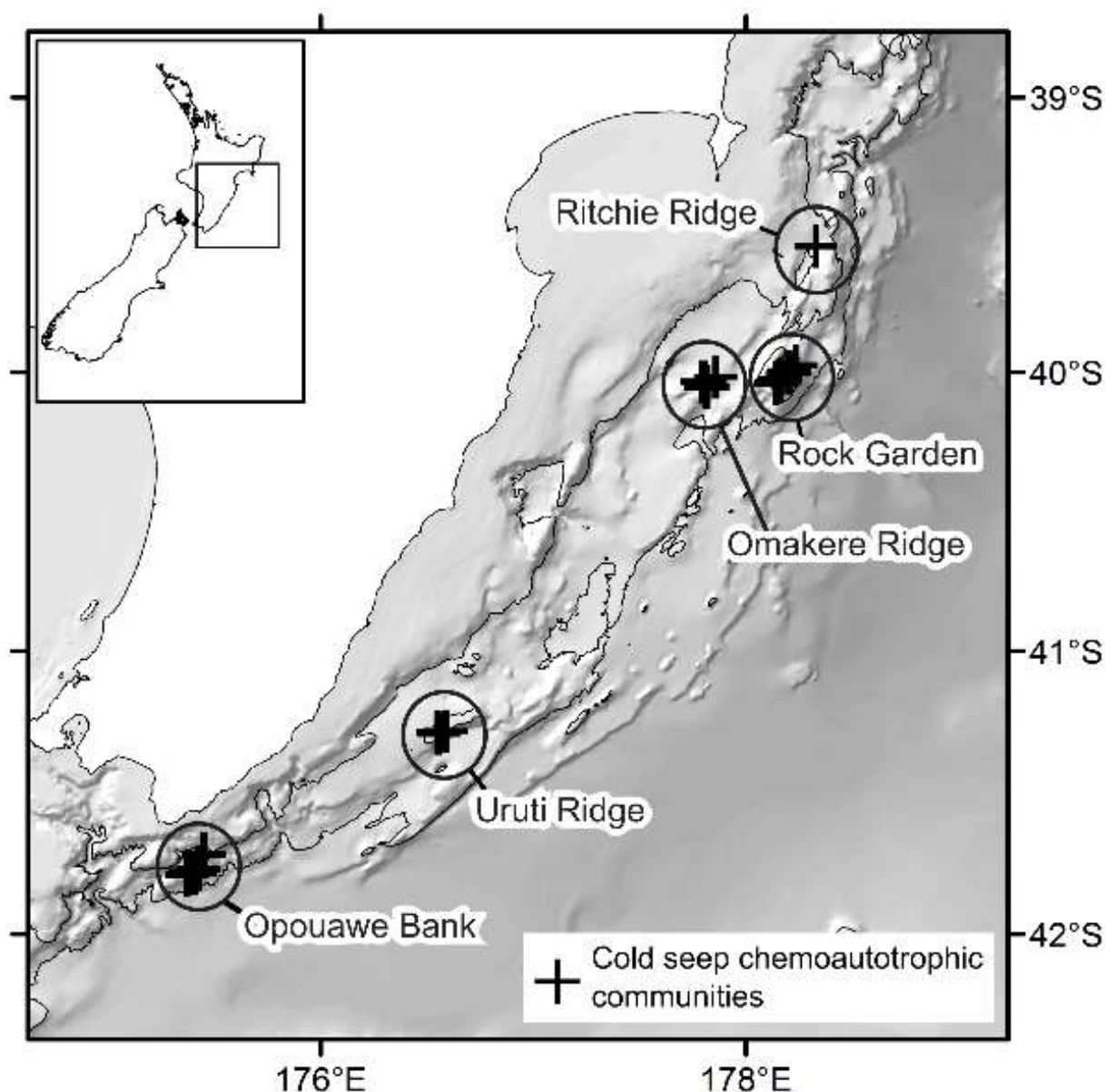


Figure 3-11: The Hikurangi Margin off New Zealand’s North Island, indicating sites at which methane seeps with chemoautotrophic benthic communities have been recorded. Opuawe Bank is the only site within the Wellington Region’s CMA. Reproduced from Bowden et al. (2013).

Inside the Territorial Sea limits, active methane seeps have been confirmed only on Opuawe Bank at the south-west end of the Hikurangi Margin but evidence of seep-associated fauna has been reported from three sites near the head of Nicholson Canyon, just south of Wellington Harbour (Baco et al. 2010, Bowden et al. 2013). No other methane seeps are known to occur within the territorial seas around any other part of New Zealand. Opuawe Bank lies 23 km southeast of Cape Palliser at the southern tip of the Wellington Region. It is an east-northeast-striking plateau approximately 70 km² in area and ranging in depth from 815 m to 1,200 m (Figure 3.10). Active methane seeps and one extinct seep site have been identified on Opuawe Bank by surveys using seafloor photography, multibeam sonar, side-scan sonar, and a range of specialised geophysical methods (Greinert et al. 2010; Watson et al. 2019). The seep sites are relatively small features, each about 10 ha or less in extent. The seven seeps shown in Figure 3-10 are the best-studied sites to date and, of these, *Tui*,

North Tower, South Tower, and Piwakawaka have the highest densities of seep-associated seabed fauna (Baco et al. 2010; Greinert et al. 2010; Bowden et al. 2013).

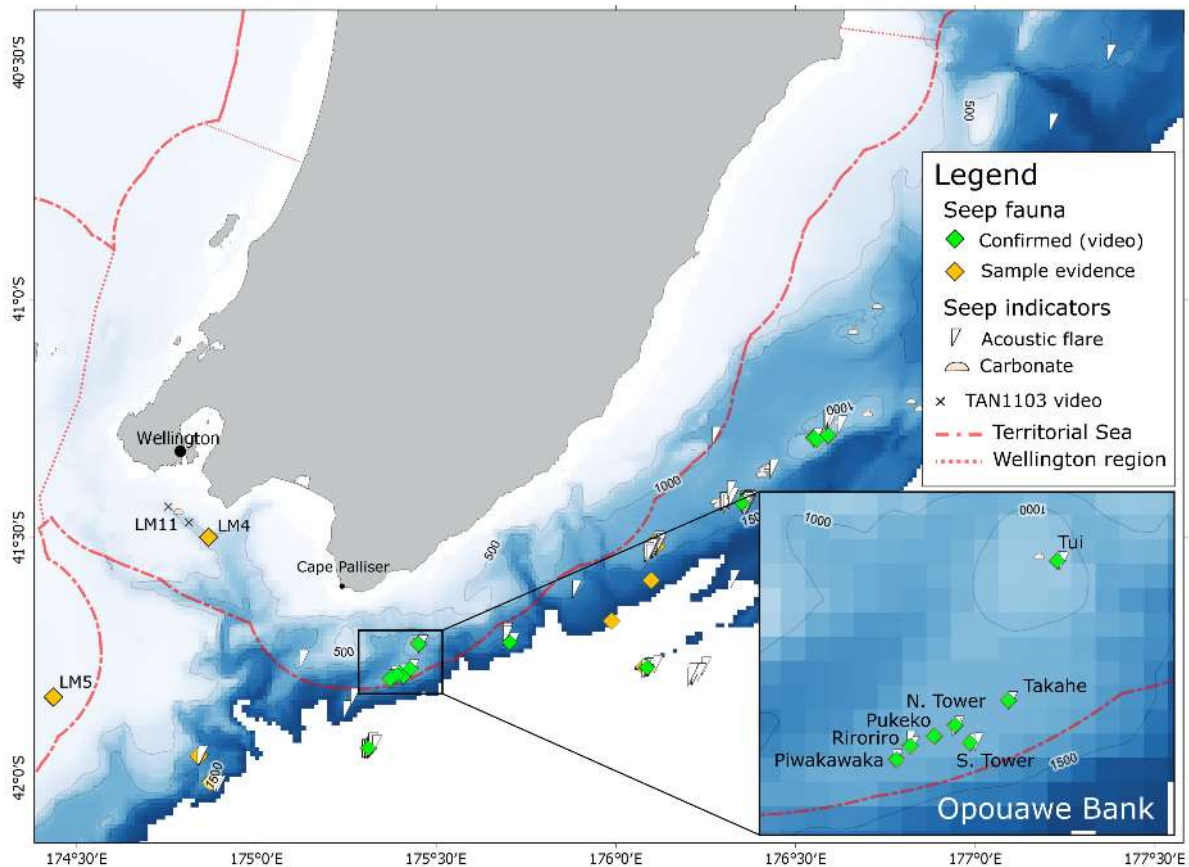


Figure 3-12: Locations of methane seeps on the southern Hikurangi Margin and in Cook Strait at which chemoautotrophic fauna have been recorded, with sites on Opuawe Bank named in inset map. Symbols differentiate between sites at which live faunal communities have been recorded by seabed video surveys (green), and those known only from specimens captured in core or trawl samples (orange). The prefix ‘LM’ identifies sites reported in Lewis & Marshall (1996). Water column flares detected by ship-borne sonar indicate locations where methane-rich fluids escape from the seabed and areas of carbonate rock, which is formed by biogenic activity at seep sites, indicate locations of past or present seep sites (Watson et al. (2019). Crosses indicate two sites in Nicholson Canyon where photographic transects were run to search for signs of seep activity during NIWA voyage TAN1103, and at which no seep fauna were observed.

Two indications of potential seep sites in Cook Strait have been reported (Lewis & Marshall 1996), both in Nicholson Canyon south of the entrance to Wellington Harbour. Site LM4 was identified on the basis of a single fresh valve of the bivalve *Maorithyas* species. Site LM11 was identified from a photograph of a carbonate chimney emerging from the sediment but no seep fauna were observed either in the original image or in subsequent seafloor video transects (RV *Tangaroa* voyage TAN1103). Small patches of bacterial mats were recorded in these 2011 transects (NIWA, unpublished data and images), and these may be indicative of seep activity in the canyon.

3.7.2 Biodiversity values

General values:

As in other reported seep provinces around the world, methane seeps in New Zealand support associated communities of highly specialised chemoautotrophic organisms. Characteristic fauna

include large vestimentiferan tube worms in the polychaete family Siboglinidae, vesicomylid clams, and bathymodiolid mussels. Other abundant taxa may include: pogonophoran worms; thyasirid, solemyid, and lucinid bivalves; trochid and buccinid gastropods; cladorhizid and hymedesmid sponges; bresiliid shrimps; and polynoid, dorvilleid, hesionid, and ampharetid polychaetes. At a species level, much of the seep-associated fauna identified so far appears either to be new to science, or endemic to New Zealand seeps, or both, suggesting the New Zealand region may represent a new biogeographic province for cold-seep fauna. Some overlap at the species and genus levels is also indicated between the seep communities and the fauna of hydrothermal vents on the Kermadec Arc and the wider Pacific (Baco et al. 2010; Bowden et al. 2013; McCowin et al. 2019).

Site specific values:

Characterisation of faunal communities at all known methane seep sites on the Hikurangi Margin by Baco et al. (2010) and Bowden et al. (2013) shows that community composition at the Opouawe Bank sites is typical of other sites on the Margin at similar depths. Most sites have emergent carbonate precipitates that form islands of hard substrata in the otherwise soft muddy sand sediments of the Bank. Conspicuous seep-associated fauna on and around the carbonates include aggregations of siboglinid tube worms (*Lamellibrachia columna*, McCowin et al. 2019) (Figure 3-11a), encrusting sponges (*Pseudosuberites thurberi*, Kelly & Rowden 2019) (Figure 3-11b), vesicomylid clams (*Calyptogena* spp.) (Figure 3-11 c), and bathymodiolid mussels (*Bathymodiolus* spp., Von Cosel & Marshall 2003), with bacterial mats and characteristic patches of dark, sulphide-rich sediment indicating areas of current seepage. The sulphide-rich patches are often colonised by dense populations of ampharetid polychaetes (representing two undescribed genera, Sommer et al. 2010) (Figure 3-11d). Commonly occurring mobile megafauna include predatory gastropods and pagurid, lithodid and brachyuran crabs. Soft-sediment habitats surrounding the carbonates support populations of pogonophoran worms (three species of *Siboglinum*), solemyid clams (*Acharax clarificata*, Walton 2015), and thalassinid shrimps (*Vulcanocalliax* sp.). Core and grab sediment samples have revealed numerous additional undescribed species of peracarid crustaceans and polychaete worms (Baco et al. 2010).

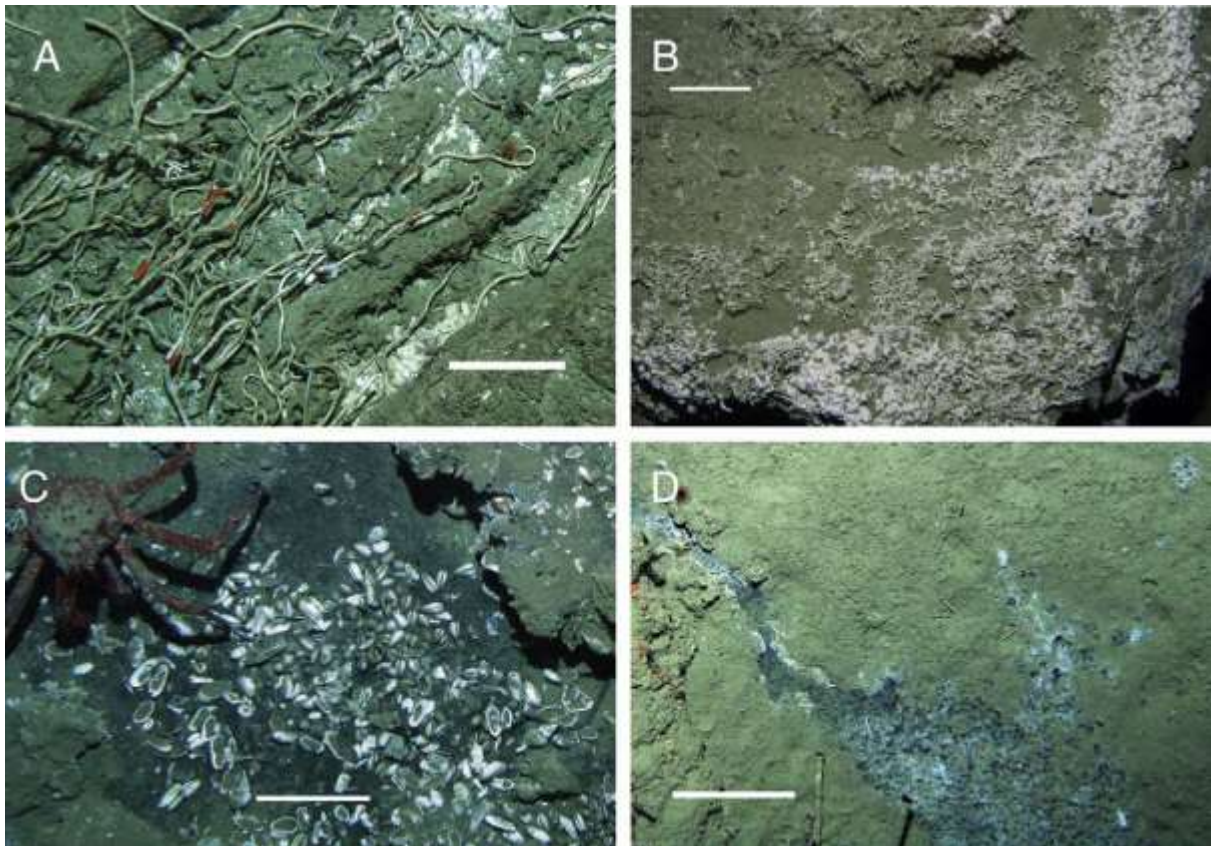


Figure 3-13: Representative megafauna and microhabitats found at methane seeps on the Hikurangi Margin. (A) *Lamellibrachia* sp. aggregation in moderate abundance on carbonate platform, Hihi; (B) Sponges (*Pseudosuberites* sp.) covering carbonate rock, North Tower (C) Live vesicomyid (*Calyptogena* sp.) clams and dead shells in a seepage-darkened sediment patch, North Tower; (D) Bacterial mat on sulphidic sediment with pits made by ampharetid polychaetes, Hihi (from Baco et al. 2010). Scale bars show 20 cm.

The Opouawe Bank methane seep sites clearly meet the GWRC biodiversity criteria for rarity, diversity, and ecological context.

Rarity: – Methane seep sites with well-developed communities of chemoautotrophic fauna appear to be relatively rare within the New Zealand region as a whole. All confirmed sites to date are limited to the southern Hikurangi Margin, and the sites on Opouawe Bank are the only ones confirmed to exist within the CMA (12 NM). Observations of bacterial mats and a single specimen of a seep-associated bivalve in Nicholson Canyon suggest that other sites may yet be discovered. However, all seep sites with abundant fauna that have been discovered to date are associated with conspicuous water-column acoustic ‘flares’ caused by methane rich fluids in the water-column. Because no such flares have been detected at the Nicholson Canyon sites, it is unlikely that rich faunal communities will be found there.

Diversity: – The communities of chemoautotrophic fauna found on Opouawe Bank seep sites are unlike any other marine fauna in the Wellington Region, consisting in large part of taxa at the family, genus, and species-levels that have been recorded only at seep sites. Several of the seep-associated taxa identified to date are either new to science, endemic to New Zealand seeps, or restricted to seep and hydrothermal vent habitats in the western Pacific, or all three, and it has been proposed that the Wellington region may represent a new biogeographic province for cold-seep fauna (Baco et al. 2010), or at least the southern extremity of a wider western-Pacific province. At local to intermediate scales within the EEZ, the specialised communities of organisms associated with sites of

methane seepage increase diversity by contributing to the mosaic of habitat types (Thurber et al. 2013; Bowden et al. 2016; Leduc et al. 2016; Rowden et al. 2016).

Ecological context: – In addition to the fauna that rely directly on chemoautotrophy, there are communities at seep sites on the Hikurangi Margin, including those on Opouawe Bank, in which some normally heterotrophic fauna are largely fuelled by methane-derived carbon (Thurber et al. 2010; Thurber et al. 2013). Methane seep sites have relatively high productivity compared to the surrounding deep-sea habitats and some common mobile non-chemoautotrophic megafauna, including predatory gastropods and pagurid and lithodid crabs, are known to exploit the rich food resources on the peripheries of the seeps (Levin et al. 2016; Seabrook et al. 2019; Turner et al. 2020). The spatial extent of influence of methane seepage and associated communities extends beyond the localised occurrence of characteristic megafauna, probably enhancing both diversity and productivity in surrounding sediments and in the water column above (Levin et al. 2016; Demopoulos et al. 2018). Some of the specialised fauna associated with methane seeps also occur on whale falls and at hydrothermal vents and it is thought likely that individual seep sites constitute nodes in a wider network of such habitats, linked by larval dispersal (Smith et al. 2001; Levin et al. 2016).

3.7.4 Threats – present and future

The seep fauna may be long-lived making them vulnerable to disturbance (Bowden et al. 2013), Siboglinid tube worms, in particular, having an estimated lifespan of up to 250 years (Fisher et al. 1997; Bergquist et al. 2000). The most immediate current threat to the Opouawe Bank seep sites is from bottom-contact trawl fisheries. Seabed scour marks caused by trawl doors, abandoned nets and cables, and damaged fauna have been observed at several seep sites on the Hikurangi Margin, including those on Opouawe Bank (Baco et al. 2010; Klauke et al. 2010; Bowden et al. 2013) (Figure 3-12).

Future threats stem from growing interests in the exploitation of the gas hydrate resources. Seeps could be directly affected during the placement of exploration and production rigs and their anchoring systems. Indirect effects could occur through methane extraction decreasing or altering the flow of methane to seep sites (Baco et al. 2010, Bowden et al. 2013, Bernardino et al. 2020).

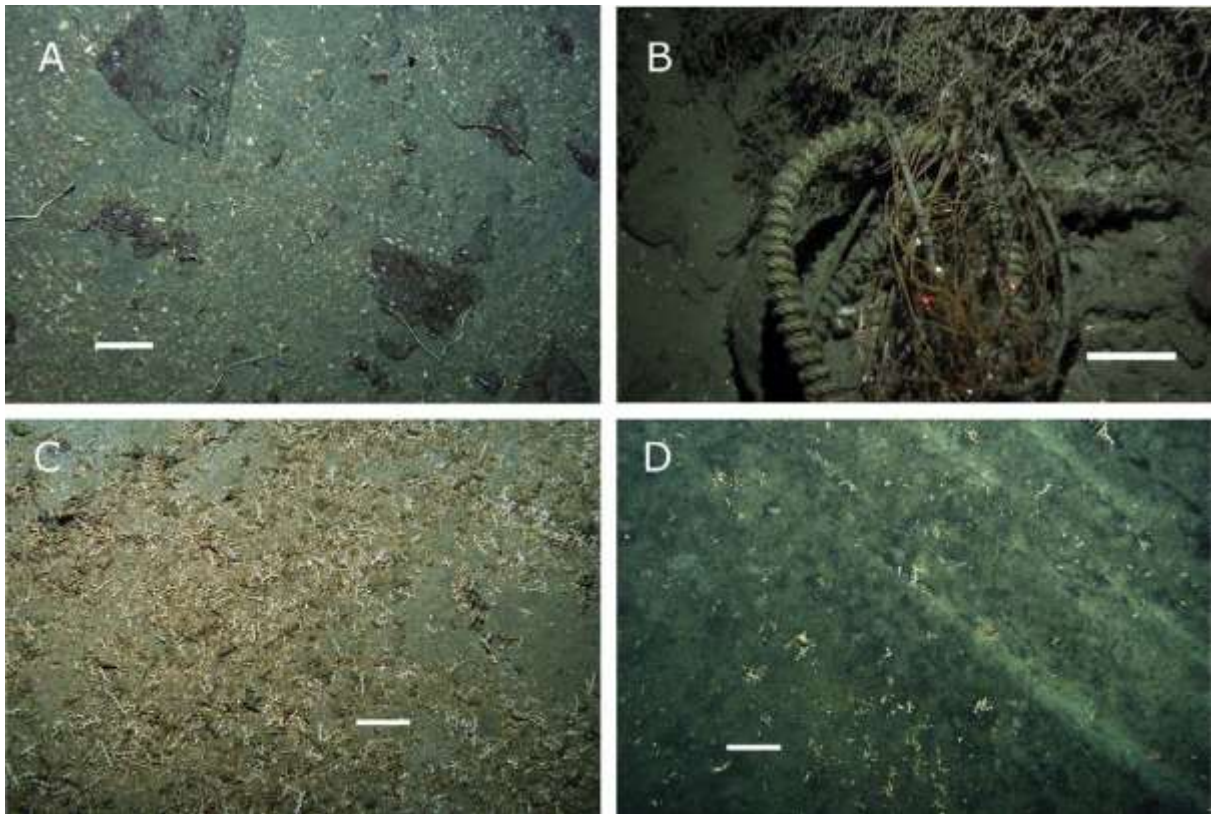


Figure 3-14: Observation of trawling damage on or adjacent to seep sites on the Hikurangi Margin. (A) apparently recently trawled seep fauna, Builder's Pencil; (B) lost trawl gear, Hihi; (C) coral rubble, Hihi; and (D) trawl drag marks in sediments, Kereru; trawl marks and coral rubble were also observed adjacent to several additional sites (see text). Scale bars show 20 cm. (Reproduced from Baco et al. 2010). Scale bars show 20 cm

3.7.5 Existing status and levels of protection

The Opuawe Bank methane seep sites currently have no special status or protection but the conservation status of at least one obligate seep taxon, the bivalve *Bathymodiolus tangaroa*, is considered to be 'Nationally Critical' (Freeman et al. 2013), while beyond the Territorial Sea cold seep habitats are recognised as Sensitive Environments in New Zealand's EEZ (MacDiarmid et al. 2013), and as Vulnerable Marine Ecosystems in international waters (FAO 2009).

3.7.6 Site relevant references

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3.8 Outer Cook Strait seamounts

3.8.1 Description

Seamounts are underwater topographic features that are typically formed of hard rock substrate, often volcanic in nature, and are particularly common in the Pacific Ocean (Yesson et al. 2011). There are >3000 hills, knolls and seamounts in the New Zealand region recorded in the current version of NIWA's SEAMOUNT database (Rowden et al. 2008). From an ecological perspective, any such underwater topographic feature with an elevation >100 m can be considered under the collective term of seamount (Pitcher et al. 2007). There are two seamounts within the area of the territorial sea for which GWRC is responsible, identified by their registration numbers as #310 and #516 in the SEAMOUNT database (Table 3-2). Seamount 516 is unofficially known as "Fisherman's Pinnacle". Seamount 310 is on the Hikurangi Margin (east coast of lower North Island) with a base of 17 km² at approximately 1000 m water depth and has an elevation of approximately 500 m. Seamount 516 is situated in the western entrance to Cook Strait, 15 km west of Mana Island, with a base of 2.21 km² at approximately 300 m water depth and rises to within 10 m of the sea surface (Figure 3-15).

Table 3-2: Seamounts within the GWRC Territorial Sea area. Showing: registration number in NIWA's SEAMOUNT database; name (where present); spatial coordinates; water depth at the peak and base, and the area covered by the seamount at its base.

Registration #	Name	Latitude	Longitude	Peak depth (m)	Base depth (m)	Basal area (km ²)
310	N/A	-41.3252	176.1914	500	1016	17.00
516	Fisherman's Pinnacle	-41.067	174.6000	10	300	2.21

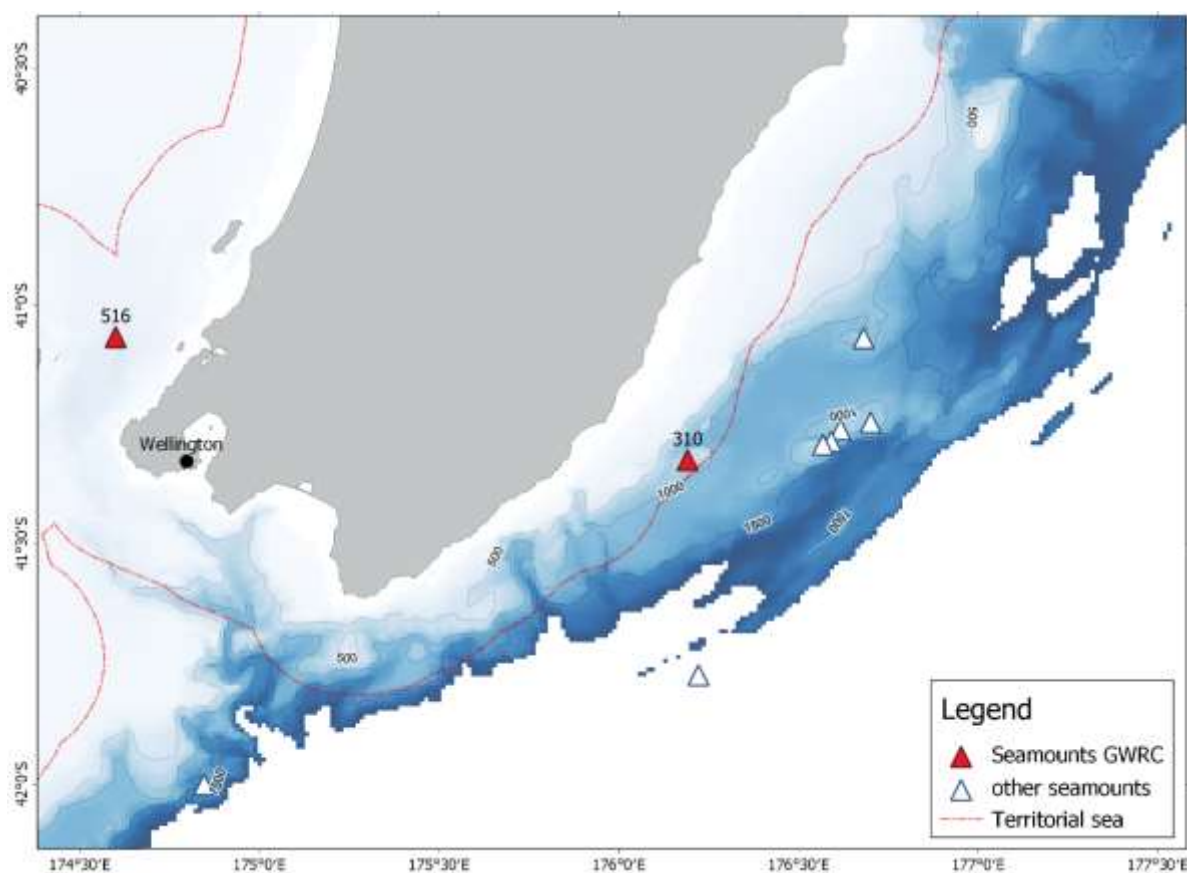


Figure 3-15: Location of seamounts 310 and 516 within the Territorial Sea boundary, and all other registered seamount features in the mapped area.

3.8.2 Biodiversity values

General values:

Seamounts can provide important habitat for benthic communities (Clark et al. 2010). Some seamounts support relatively abundant populations of sessile-feeding animals such as cold-water corals, which in turn can provide habitat for diverse assemblages of other invertebrates (Rogers et al. 2007). Thus, seamounts can have relatively high benthic biomass by comparison with surrounding habitats (Rowden et al. 2010). Seamounts are often the focus of commercial fisheries because populations of some fish species concentrate on and around these features, either permanently or temporarily (Clark et al. 2007). However, not all seamounts support rich benthic or pelagic communities because the value of seamounts as habitat is dependent on a range of factors that can vary at local, regional, and ocean-basin scales (Rowden et al. 2010).

Site specific values:

Less than a hundred seamounts in the New Zealand region have been the subject of any focused biological study. Seamount 516 is a steep-sided pinnacle feature that has not, according to records in NIWA's databases, been sampled for benthic biota (Figure 3-16). However, this seamount is unusual in the region in that its peak is in shallow water and could potentially, like other seamounts that extend into the photic zone, support a rich benthic community that comprises algal as well as invertebrate communities (e.g., Du Preez et al. 2016).

Seamount 310 is has an elongated east-west oriented summit at ca. 510 m depth with a gently sloping southern and steeper northern flank. Benthic meio-macro- and mega-faunal communities were sampled on seamount 310 during a NIWA research voyage in 2010 (TAN1004) using epibenthic sled (2 samples), beam trawl (1 sample), multicorer (2 samples) and a towed-camera (3 transects) from the summit down to 1000 m on the southern flank (Figure 3-16). On the summit, low-relief rock and boulder substrata, often overlain by muddy sediments, were associated with faunal communities including sponges, gorgonians, asteroids, cidaroid echinoids, motile crinoids, natant decapods, holothuroids, pagurids and scorpaenid fish (Figure 3-17). Deeper on the southern flank, substrata were of muddy-sand sediments with numerous burrows and epifauna including asteroids, holothuroids, and *Stephanocyathus* sp. solitary corals (Bowden et al. 2010). This sampling was part of a wider study to compare benthic community structure across multiple deep-sea habitats, including seamounts, in New Zealand. This study found that benthic community composition on seamount 310 was similar to those on two other seamounts included in the study on the Hikurangi Margin but also had overlaps with communities in slope and canyon habitats in the same area (Bowden et al. 2016, Leduc et al. 2016, Rowden et al. 2016, Rosili et al. 2016).

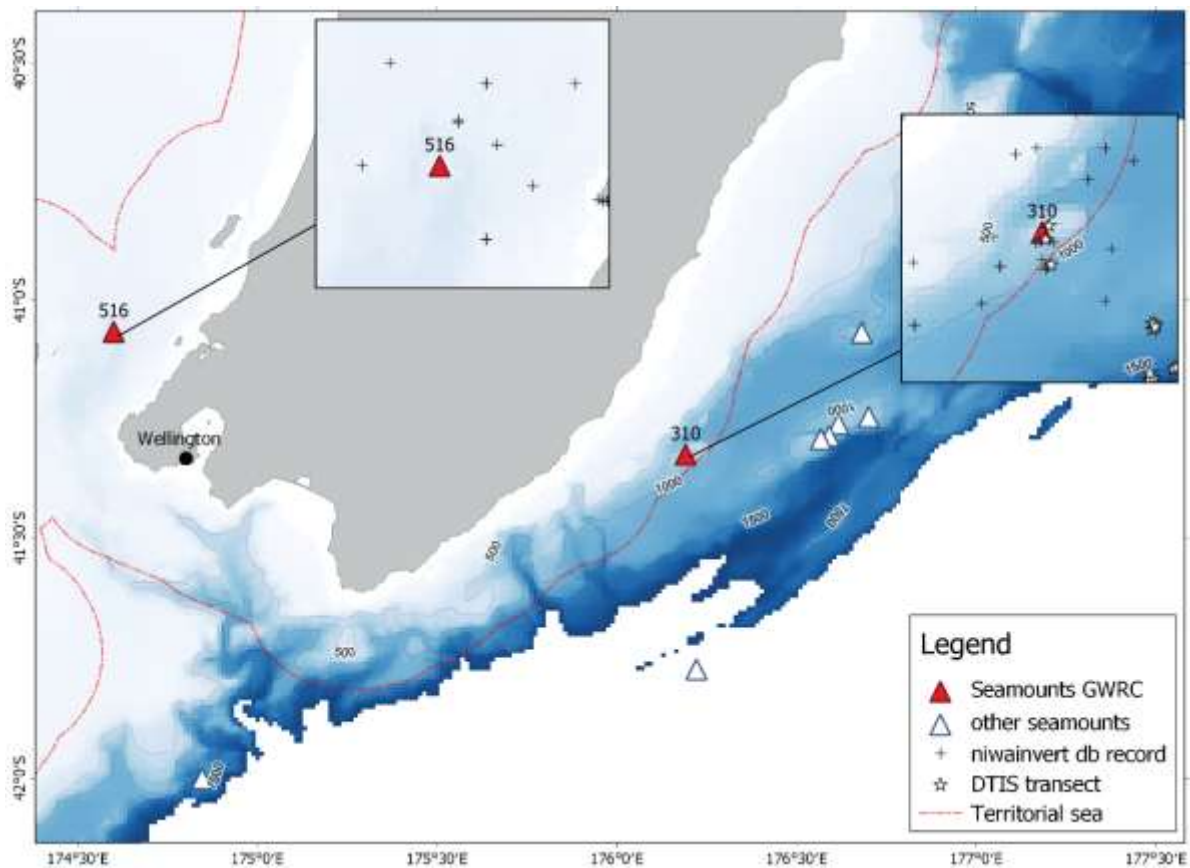


Figure 3-16: Location of biological sampling stations (crosses and stars) in the vicinity of seamounts 310 and 516 (inset maps). Biological sampling stations outside of the inset maps are not shown.



Figure 3-17: Seafloor image from the summit of seamount #310. Image captured by NIWA's Deep Towed Imaging System (DTIS) during research voyage TAN1004 (image reference: TAN1004_064_228).

Rarity:- While seamounts are common underwater topographic features in the New Zealand EEZ, there are only 21 in the mainland Territorial Sea as a whole, and only 2 in the GWRC area. Therefore, these two seamounts in the coastal marine area of the Wellington region represent a rare habitat. Furthermore, seamounts that have a peak in the photic zone and are likely to host diverse and abundant mixed algal and invertebrate benthic communities, are also very few in number in the New Zealand region. There are only 3 seamounts with a peak in water <50 m, and a further 29 with peaks in water between 50-200 m, out of >3000 seamounts currently registered in the SEAMOUNT database. Therefore, seamount 516 is a rare site in this respect, also.

Diversity:- Analysis of the available data for seamount 310 suggest that benthic communities on this seamount are not particularly diverse compared to other seamounts in the New Zealand region and share many taxa with communities in neighbouring slope and canyon habitats (Bowden et al. 2016, Leduc et al. 2016, Rowden et al. 2016, Rosili et al. 2016). There are no available data to make a biodiversity assessment for seamount 516.

Ecological context:- As already noted above, seamounts can be important ecological areas, and both seamounts could be considered important ecological areas in the area because of their relative rarity. Seamount 516, in particular, is likely to be, important in this context because it is a rare shallow water seamount that could support diverse and abundant mixed algal and invertebrate communities (Du Preez et al. 2016), and potentially act as stepping-stone source of propagules for shallow water species (O'Hara et al. 2010).

3.8.3 Threats – present and future

The principal threat posed to benthic communities on seamounts is from bottom trawling (Clark et al 2015). Data for the distribution of bottom trawling effort (i.e. fishing footprint) in the area (Figure 3-18) and the SEAMOUNT database indicate that whereas seamount 310 has been targeted by deepwater trawl fisheries (e.g., for orange roughy) for some time, seamount 516 has been avoided, presumably because its steep, rugged topography makes it a hazard to trawl fishing gear. Seamount 310 is likely to continue to be a target for bottom trawling, even though catches are relatively small (a total of ~4500 tonnes of fish caught up to 2010). Seamount 516 was long-lined commercially in 1960s-1970s for hapuku, but is now frequently fished recreationally for hapuku, warehou and blue cod. However, there are no catch statistics for this recreational fishing.

Benthic communities on seamounts are potentially threatened by the effects of climate change and ocean acidification (e.g., Ross et al. 2020). In particular, fauna that rely on forms of calcium carbonate for building skeletal structure are likely to be affected by ocean acidification, which will cause a shallowing of the depth of the carbonate saturation horizon (e.g., Guinotte et al. 2006). This change in the saturation horizon will likely alter the distribution of fauna, such as cold-water corals, both vertically and horizontally in the New Zealand region (Tracey et al. 2013). Studies have shown that in the face of continuing ocean acidification, the shallower parts of seamounts may become 'refuges' for fauna that rely on calcium carbonate (e.g., Tittensor et al. 2010). Benthic communities on the deeper seamount 310, which do include fauna that rely on carbonate for their skeletons (e.g., the scleractinian coral *Goniocorella dumosa*), could be impacted by ocean acidification, so the summit of this seamount could also act as a refuge habitat for fauna whose deeper distribution has been affected by the shallowing of the carbonate saturation horizon. The benthic communities on the relatively shallow seamount 516 are unlikely to be affected by ocean acidification, but it is likely that in the future this seamount will be exposed to unprecedented fluctuations in surface water temperatures (e.g., with increased frequency of marine heatwaves in the Tasman Sea affecting the Wellington region; Behrens et al. 2019, Salinger et al. 2019, 2020), which could influence the community structure of this shallow seamount through impacts to algal communities in particular (Thomson et al. 2019, Tait et al. 2021).

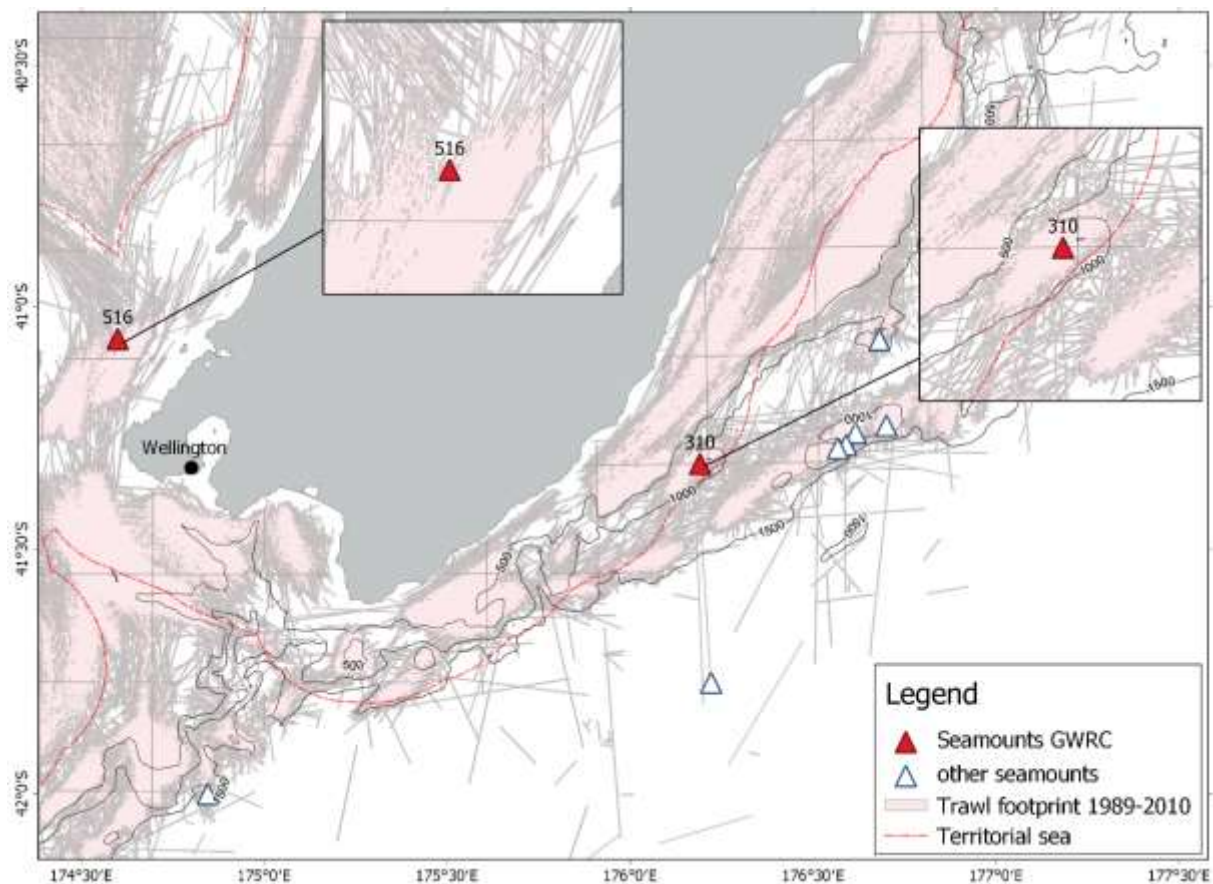


Figure 3-18: Bottom trawl footprint (period 1989-2010, data from MPI) in relation to the location of seamounts.

3.8.4 Existing status and level of protection

Neither of these two seamounts has any protection status. However, seamount 516 might be effectively protected from bottom trawling because of its steep topography which is likely to damage trawl gear.

3.8.5 Site relevant references

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4 Habitats of significance for marine biodiversity

4.1 Kelp bed habitat on exposed rocky subtidal reefs

4.1.1 Description

Kelp beds are recognised worldwide as key contributors to coastal ecosystems through the energy captured via photosynthesis, the provision of highly structured three-dimensional habitats, and also through the fixed carbon retained within, and exported from, coastal kelp forests (e.g., Graham 2004). Kelp beds occur on shallow (< 50 m) rocky reefs throughout New Zealand.

The term 'kelp' is used for two different groups of large brown algae in New Zealand – the true kelps or members of the Laminariales, and bull kelp, or species of the genus *Durvillaea*, belonging to the Fucales. These two orders of brown algae have fundamentally different life histories. Members of the Laminariales have a heteromorphic life history where the conspicuous kelp phase is the diploid stage (sporophyte) alternating with a microscopic gametophyte phase that produces eggs and sperm. In contrast, the Fucales have a direct life history with the production of eggs and sperm and no alternate life history stage. Understanding life histories in brown algae is critical to understanding algal ecology and population dynamics (Schiel & Foster 2006).

Members of the Laminariales native to the rocky reefs of the Wellington Region are *Macrocystis pyrifera* (refer 4.2) *Ecklonia radiata* and *Lessonia variegata* (Figure 4-4), while the introduced Asian kelp *Undaria pinnatifida* is also a true kelp. Bull kelps are members of the Fucales and are represented by *Durvillaea antarctica* in the Wellington Region. Although *D. willana* has been reported on the Wairarapa coast, these records are based solely on records of drift specimens.



Figure 4-1: Mixed beds of *Lessonia variegata* (foreground and background) and *Ecklonia radiata* (middle). Photo courtesy of S. Schiaparelli.

The decline of subtidal macroalgal forests has been reported worldwide in temperate and subtropical regions (summarised in D'Archino et al. 2019). Loss or decline is especially evident on urbanised coastlines (e.g., *Phyllospora comosa* around Sydney - Coleman et al. 2008; Campbell et al. 2014; *Ecklonia radiata* around Adelaide - Connell et al. 2008; loss of Fucales in France - Thibaut et al. 2005) or has been documented in response to an extreme climatic event (e.g., Wernberg et al. 2016; Johnson et al. 2011).

Recently the loss of *Durvillaea* spp. was documented in the South Island as a result of the heatwave in 2017-2018 (Thomsen et al. 2019). The conservation status of *D. poha*, *D. antarctica* and *Macrocystis pyrifera*, previously not considered to be at risk (Hitchmough et al. 2007), has been assessed as 'at risk – declining' together with two species that are associated only with *Durvillaea* species (Nelson et al. 2019).

Recently the use of machine learning (ML) has been investigated to analyse underwater videos and detect the presence of macroalgae (D'Archino et al. 2019). An algorithm has been developed to automatically identify *Ecklonia radiata*, *Lessonia variegata* and *Carpophyllum* spp. and a wider category of 'all macroalgae'. A pilot study was carried out in the Taputeranga Marine Reserve (Island Bay to Houghton Bay) to improve and test this approach. Results showed that ML can provide a significantly faster, cost-effective approach to post-processing video imagery and could be applied for monitoring the spatial extent of subtidal kelp forests (D'Archino et al. 2020).

***Ecklonia*:** In New Zealand waters *Ecklonia radiata* is the ubiquitous kelp, found from the Three King Islands in the north to Stewart Island in the south (Adams 1994). *Ecklonia* is abundant in the Wellington Region on rocky reefs, grows subtidally on rocky shores from moderate shelter through to exposed coasts, and can be found in the shallow intertidal zone to depths greater than 25 m (Schiel & Nelson 1990; D'Archino et al. 2019). The importance of *Ecklonia* to marine communities is well documented. Jones (1984, 1988) showed that reef fishes such as wrasses and monacanthids recruit, some exclusively, among the fronds of *Ecklonia* and feed exclusively on small invertebrates within them. Choat & Ayling (1987) showed that the presence of *Ecklonia* beds affects the character of the fish fauna throughout northern New Zealand. Sea urchins do not recruit or survive well as juveniles in *Ecklonia* beds (Andrew & Choat 1985). The ecology and physiology of *Ecklonia* has been well studied in north eastern New Zealand and in Fiordland but equivalent work is not available for the Wellington Region.

***Lessonia*:** *Lessonia variegata* (Figure 4-5) is reported from around the North, South and Stewart Islands, although recent work using molecular markers suggests that this species has a much more restricted distribution, and is found only in the lower North Island and northern South Island in the vicinity of Cook Strait, with an additional three species to be described in New Zealand (Zuccarello & Martin 2016). Beds of *L. variegata* are found subtidally on very exposed rocky reefs. It is not known how long-lived individuals are, although it is speculated that large clumps may exceed eight years in age. The sporophytes of *Lessonia* are fertile in winter (Schwarz et al. 2006).



Figure 4-2: Two views of *Lessonia variegata* showing the range in colour and stipe length. Photos courtesy of S. Schiaparelli.

***Durvillaea*:** *Durvillaea antarctica* (Figure 4-6) is the most commonly found species in the genus in New Zealand, occurring from the Three Kings Islands south to the subantarctic islands. It is found only on the most exposed headlands in the northern North Island in the low intertidal zone, becoming more common from Cook Strait south. It is the largest species in the genus with an unbranched stipe and blades which can grow to 10 m in length. The blades are supported by gas-filled air sacs within the plant in a honeycomb-like network.



Figure 4-3: *Durvillaea antarctica* on an unusually calm low tide. The short tough stipe and holdfast are shown front left with the long blades trailing through to the top centre of the image. Image courtesy of S. Schiaparelli.

Durvillaea willana is considered to be restricted to the South and Stewart Islands although it has been recorded on the Wairarapa coast (although solely from drift specimens).

Durvillaea spp. are fertile from late autumn to early spring (April to September) with peak fertility in June to July (Hay 1994; Velásquez et al. 2020). Large *D. antarctica* thalli may be 10 years old but more typically are 5-8 years.

4.1.2 Biodiversity values

General values

Kelp beds are recognised as ecosystem engineers providing three-dimensional habitat space and structure to the environment in rocky reef habitats. Each of the kelp species has unique features and occupies unique habitats. Kelp beds are known to support high biodiversity and are critical to food chains.

The work by Pérez-Matus and Shima (2010a) explored the relationships between the structural complexity of kelps and the abundance of temperate reef fishes in the Wellington Region. They detected within-species variation in responses to macroalgal composition with the identity of the macroalgae present affecting the abundance of 7 of 15 reef fish species evaluated. In addition, the composition of the macroalgal stands shaped the abundance of 5 of 7 reef fish species, and the overall structure of the local fish assemblage. They found that in general the heterogeneity in vegetative structures appeared to increase breadth of habitat use for reef fishes.

Habitat specific values:

Lessonia

Present on exposed subtidal sites, thick beds of *Lessonia* provide shelter and habitat for a range of species. Some research is available on the growth of this species in the Wellington Region (Schwarz et al. 2006) but there have been no specific studies of biodiversity associated with this kelp.

Ecklonia

Common and abundant, *Ecklonia* is important because of its provision of habitat and the associated biodiversity.

Durvillaea

Durvillaea occupies a very specific niche in the low intertidal zone of very exposed headlands. There is a suite of species typically associated with *Durvillaea* that have similar environmental requirements including non-geniculate coralline algae.

4.1.3 Habitat features relevant to criteria

Representativeness: – Beds of *Lessonia*, *Ecklonia* and *Durvillaea* occur within both of the existing marine reserves in the Wellington Region which afford protection within both the Abel and Cook Bioregions. However, the proportion of populations protected is < 20%, and is especially restricted within the Cook Bioregion where it is unprotected along the whole of the Wairarapa coast.

Rarity: – not applicable

Diversity: – Each of the kelps occupy a distinct and different habitat/niche and are associated with different flora and fauna. *Ecklonia* occurs over a wide depth range but is generally absent from

shallow, very exposed sites. *Lessonia* occurs at exposed sites over a range of depths. *Durvillaea* occurs in a narrow depth zone in shallow subtidal and low intertidal waters on very exposed headlands. Within each kelp bed a variety of microhabitats occur from holdfast to algal canopy, each with an associated community of epiphytes, fish and invertebrates.

Ecological context: – Kelp beds provide a key habitat for a variety of fish and invertebrates, including commercially, recreationally and culturally important species such as paua, kina, and rock lobsters. As major primary producers, kelps also fuel the local reef ecosystem, while drift algae helps to sustain adjacent beaches and deeper habitats (see Kelly et al. 2012).

4.1.4 Threats – present and future

Present threats to kelp beds on exposed coasts include sedimentation, indirect effects of fishing, and invasive species (MacDiarmid et al. 2012a, b). Kelp forest ecosystems are generally vulnerable to potential changes in climate because they are sensitive to (1) increased temperatures (in terms of extremes and duration of events), and associated decreases in nutrient availability, (2) increased storminess, (3) increased turbidity and resulting decreases in light penetration with depth, and (4) outbreaks of herbivores due to depletions of predators (e.g., resulting from the combined effects of fishing and climate change), or due to invasions of herbivores (e.g., resulting from climate-related range shifts or human-facilitated transport) (Hobday et al. 2006). Ocean acidification may have impacts both on kelps and on associated species.

4.1.5 Existing status and levels of protection

While beds of *Lessonia*, *Ecklonia* and *Durvillaea* occur within one or both of the existing marine reserves in the Wellington Region, there is no protection provided for kelp beds and the associated reef communities along the Wairarapa coast. Given they provide critical habitat for a range of associated species and are significant primary producers, protection of these kelp beds warrants attention.

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4.2 Giant kelp (*Macrocystis*) habitat

4.2.1 Description

Giant kelp (*Macrocystis pyrifera*) thalli are perennial and grow to 20 m in length. *Macrocystis* frequently forms colonies or large populations in calm bays, harbours or in sheltered offshore waters. It can tolerate a wide range of water motion including areas where tidal currents reach 5-7 knots (Hay 1990). *Macrocystis* forests are characterised as being amongst the most productive marine communities in temperate waters. Schiel & Foster (1992) stated “the high productivity and habitat complexity of these plants contribute to the formation of diverse communities with considerable ecological, aesthetic and economic value. Moreover, food and habitat are exported from kelp forests to associated communities such as sandy beaches and the deep sea”. *Macrocystis*, like other members of the Laminariales, have a heteromorphic life history where the conspicuous kelp phase is the diploid stage (sporophyte) alternating with a microscopic benthic gametophyte phase that produce eggs and sperm.

Macrocystis pyrifera has been reported to occur from the southern North Island around Cook Strait (from Kāpiti Island on the west coast to Castlepoint on the east coast), to the South, Stewart, Chatham, Bounty, Antipodes, Auckland and Campbell Islands (Adams 1994; D’Archino et al. 2019). Its distribution is patchy and there is both seasonal and interannual variation in abundance (Hay 1990; Pirker et al. 2000). *Macrocystis* beds in the Wellington Region have been reported near Kāpiti Island, at Makara, in Island Bay, at the entrance to the Wellington Harbour (along the bays between Seatoun and Kau Bay (Figure 4-1) and on the eastern shore from Point Howard to Hinds Point), near Petone, Whatarangi (Palliser Bay) and Castlepoint. Adams (1972) noted that “Marked changes in the local occurrence of *Macrocystis* have taken place since 1940.” During a recent (2019) low altitude air survey along the Wairarapa coast and several macroalgal collecting trips at Castlepoint NIWA staff were not able to relocate the kelp bed on the northern Wairarapa coast (Nelson, D’Archino pers. comm.).

In 2017 a survey was carried out to map the distribution of *Macrocystis* beds in Wellington Harbour in order to compare with the distribution recorded by Hay in 1990. Although the areas covered by *Macrocystis* in 2009 and 2017 couldn’t be compared with maps in Hay (1990) (as the size of the beds has been exaggerated for clarity) the survey in 2017 highlighted areas of persistence or change of *Macrocystis* beds in Wellington Harbour. In contrast to Hay’s 1990 observation, *Macrocystis* was not found in Evans Bay, at Point Halswell, on the southern side of Matiu Somes Island and at Aotea Quay in 2017. *Macrocystis* was still present, although only as a narrow strip, along the motorway adjacent to the Ngauranga interchange (D’Archino et al. 2019).



Figure 4-4: Giant kelp, *Macrocystis pyrifera* at Kau Point (Wellington Harbour). Image courtesy of Nicole Miller.

In 2016 the Wellington Underwater Club started Project Baseline Wellington to monitor the *Macrocystis* bed at Kau Point (Wellington Harbour) every six months. Volunteer snorkelers have been swimming offshore around the bed to acquire GPS data and drone surveys have been carried out at low tide to delimitate the extent of the bed. The area was then correlated to water temperature data collected by GWRC at Mahanga Bay. The surveys to date show a smaller spatial extent of the bed following hot summers (2015-2016 summer water temperature was 20-21 °C; summer 2017-2018 water temperature up to 22 °C) and a recovery during the cooler months (<https://adventure360.co.nz/blog/2020-12-12-monitoring-kelp>; Appendix B).

4.2.2 Biodiversity values

General values:

Kelp beds are recognised as ecosystem engineers, providing three-dimensional habitat space and structuring to the environment in rocky reef habitats. Kelp beds are known to support high biodiversity and are critical to food chains (D'Archino et al. 2019).

Habitat specific values:

Macrocystis beds are considered to sustain “one of the most diverse, productive and dynamic ecosystems of the planet” (Graham 2004). The beds in the Wellington Region are patchily distributed and known to vary in size and position over time. Pérez-Matus & Shima (2010a, b) have explored the positive relationships between kelp structural complexity and the abundance of temperate reef fishes, and the potential indirect benefits for the giant kelp (*M. pyrifera*) of fish predation on amphipod grazers.

4.2.3 Habitat features relevant to criteria

Representativeness: – The Wellington Region is the northern distribution limit for *Macrocystis*. The position and extent of *Macrocystis* beds are known to vary inter-annually. *Macrocystis* beds are poorly represented in existing protected areas with a few beds occurring in the Taputeranga Marine Reserve on Wellington City’s south coast, and sometimes *Macrocystis* is present in the eastern part of the Kāpiti Marine Reserve, but both places represent marginal habitat areas for this species. Within the region, the densest beds occur in the entrance to Wellington Harbour along the bays between Seatoun and Kau Bay and along the eastern shore from Point Howard to Hinds Point.

Rarity: –The decline of kelp beds has been documented worldwide (summarised in D’Archino et al. 2019) and in some regions (e.g., Tasmania), *Macrocystis* beds have decreased by up to 98% (Johnson et al. 2011). The conservation status of *Macrocystis pyrifera* has been ranked as ‘at risk declining’ together with five other species, including the bull kelp *Durvillaea antarctica* which also occurs in the Wellington Region (Nelson et al. 2019).

Diversity: – Within kelp beds a variety of microhabitats occur from holdfast to algal canopy, each with an associated community of epiphytes, fish and invertebrates. This diversity is greatest in *Macrocystis* beds because they occur over the greatest vertical extent from sea floor to sea surface in depths of 10 m or more.

Ecological context: – *Macrocystis* beds provide a key habitat for a variety of fish and invertebrates (Figure 4-2), including commercially, recreationally and culturally important species such as paua (*Haliotis iris*), kina (*Evechinus chloroticus*), and rock lobsters (*Jasus edwardsii*). As a major primary producer *Macrocystis* also fuels the local reef ecosystem, while drift algae help to sustain adjacent beach and deeper water habitats. The strong shading provided by dense canopies of giant kelp allows deeper water sponges to grow in shallow water (Alison MacDiarmid, NIWA – personal observation).



Figure 4-5: Crayfish nursey under the canopy of *Macrocystis pyrifera* at Kau Point in Wellington Harbour.
Photo: Roberta D'Archino (NIWA).

4.2.4 Threats – present and future

A global study of trends in changes in kelp forests over the past half-century detected regions with high probability of decline in Central Chile, the Aleutian Islands, the South Australian Gulf, the North Sea, North-Central California and the Bassian ecoregion (Krumhansl et al. 2016). The study however didn't include data for *Macrocystis pyrifera* from New Zealand. Cases of documented decline of giant kelp in New Zealand are scarce [e.g., the Marlborough Sounds (Hay 1990) and a decrease in the East Otago Taiāpure Marine Reserve between 2009 and 2017 (D'Archino et al. 2019)], due the lack of baseline data which are necessary to understand seasonal fluctuations and the response of *Macrocystis* to local stressors. However, frequent anecdotal reporting of decline has raised concerns in the scientific community and in the public.

As outlined in the previous section, kelp forest ecosystems are generally vulnerable to potential changes in climate, as well as to invasions of non-native herbivores. Declines in the *Macrocystis* populations off the coasts of Tasmania have been recently documented (Johnson et al. 2011). It is thought that in the Wellington Region *Macrocystis* may be particularly vulnerable to climate change as it is already at the northern limit of its distribution. Ocean acidification may impact on associated species.

Macrocystis may be most directly threatened by harvesting under the Quota Management System (QMS) though a lack of research prevents firm conclusions about the safe level of harvesting.

Currently harvesting of *Macrocystis* under the QMS is taking place in Fisheries Management Areas in the South Island.

A possible threat to seaweed and giant kelp is the increase in sea urchin abundance (*Evechinus chloroticus*). Recently kina barrens have been noticed during the monitoring in Kau Bay (Project Baseline Wellington) (Figure 4-3) and these may pose a risk to the local populations of *Macrocystis*. More monitoring is necessary to assess the extent of kina barrens in Wellington Harbour and their potential impact on giant kelp.



Figure 4-6: Kina in *Macrocystis* bed at Kau Bay August 2019. Photo courtesy of Nicole Miller.

Another threat to the *Macrocystis* beds in Wellington Harbour is sedimentation associated with dredging of the entrance to allow the port to host large vessels and road works along the harbour margins. The *Macrocystis* beds at Moa Point and in Lyall Bay could be negatively affected by proposed seafloor engineering for the Wellington Airport extension project, which could suspend sediments reducing available light and potentially smother the gametophyte phase and recruiting sporophytes.

4.2.5 Existing status and levels of protection

Macrocystis can be legally harvested according to limits set by the Minister for Primary Industries under the QMS. At present there is no quota provided for the Wellington Region.

Macrocystis beds are poorly represented in existing protected areas. However, a few beds do occur in the Taputeranga Marine Reserve on Wellington City's south coast and may sometimes occur in the eastern part of the Kāpiti Marine Reserve. Both areas represent marginal habitat for *Macrocystis* and additional protection is required.

Without monitoring it will be difficult to distinguish between natural variation in bed size and extent and variations that occur in response to human-induced environmental changes. Mapping *Macrocystis* beds in Wellington Harbour and along the South Coast following the contour of the bed could be repeated yearly to acquire data on the spatial variability of *Macrocystis* beds.

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4.3 Deep-sea wood/*Xyloplax* (sea daisy) biogenic habitat

4.3.1 Description

The association of marine organisms with wood in the deep sea has been noted since the *Challenger* Expedition (1872–76) discovered deep-water relatives of shipworm (vermiform bivalved molluscs). However, it was not until the results of the Danish *Galathea* expeditions in 1950–52 (Wolff 1979) that deep-sea wood came to be recognised as an important habitat with an associated exceptional biota. Deep-sea wood has been dredged in New Zealand in the Kermadec Trench, in the Bay of Plenty, and off the coast of Wairarapa, Kaikōura, Timaru and Hokitika, and on Mernoo Bank near the western end of the Chatham Rise.

The wood-fall habitat first came to prominence in New Zealand in the 1980s with the discovery, off the Wairarapa coast (Figure 4-7) and in the Hokitika Canyon, at depths of 1,100–1,200 m, of a new kind of organism – sea daisies – named *Xyloplax medusiformis*. Barely 1 cm in diameter, this unusual type of echinoderm looks like small flat parachutes or medusae. They are circular and lack a mouth or arms (Figure 4-8). Their discovery made the pages of *Nature*, as it was believed they represented a sixth, new class of living echinoderms, Concentricycloidea (Baker et al. 1986). Further study of this group based on the discovery of two more species, one off the Bahamas and one in the North Pacific, has given evidence that they are actually highly modified sea stars. Following an assertion that concentricycloids are only asteroids (Janies & Mooi 1998), Mah (2006) concluded that they nevertheless comprise members of a sister group to an infraclass Neoasteroidea, which represents all other living sea stars in the class Asteroidea, but Janies et al. (2011) disagreed. Using gene-sequence and developmental data from recently collected *Xyloplax* adults and embryos, Janies et al. (2011) demonstrated that *Xyloplax* is simply a sea star that is closely related to the asteroid family Pterasteridae (order Velatida). Their unusual characters are progenetic, i.e., permanently juvenile, which accounts for their strange appearance. Currently, the family Xyloplacidae is included in its own order (Peripodida) in the asteroid infraclass Concentricycloidea in the World Register of Marine Species (WoRMS).

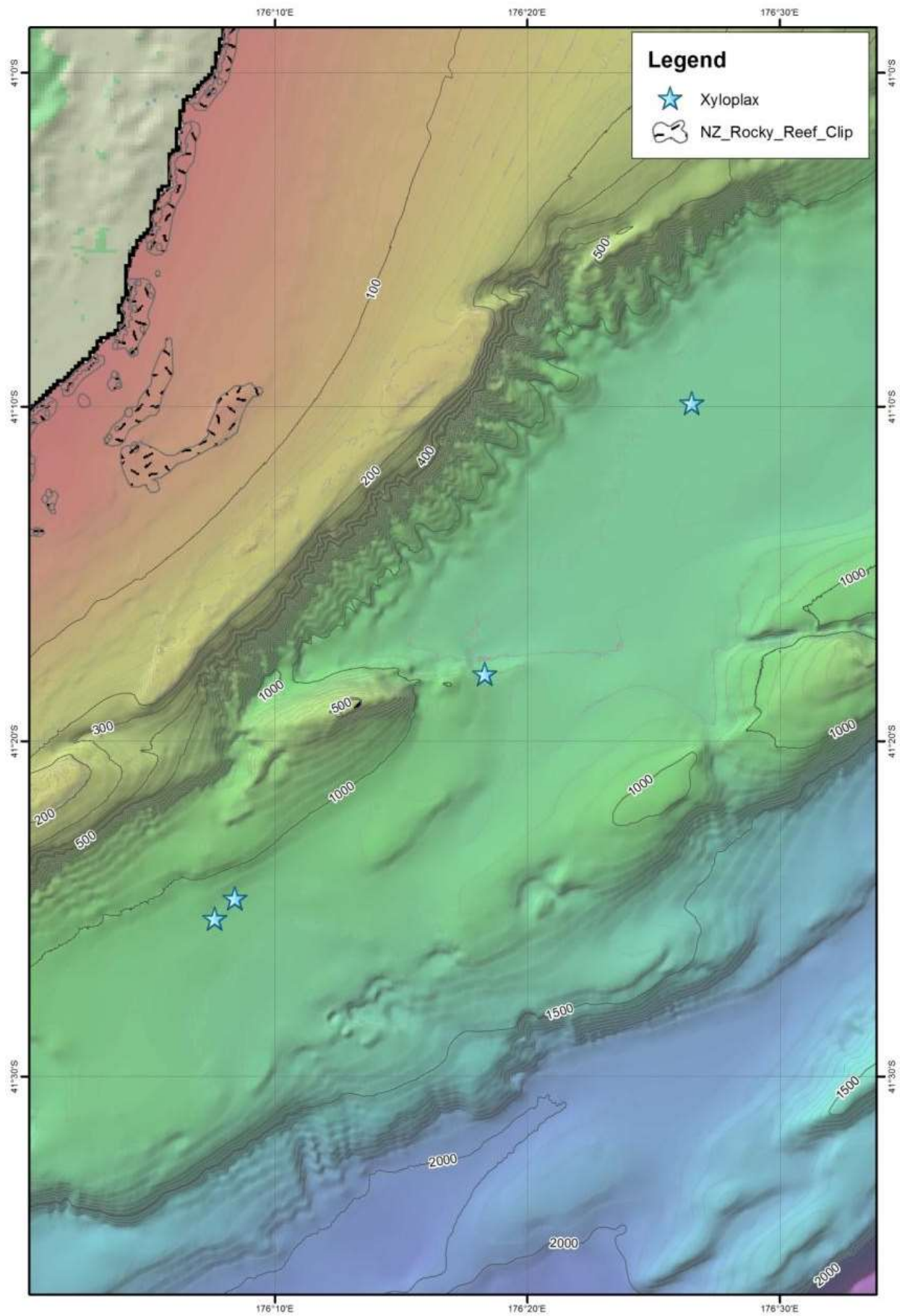


Figure 4-7: *Xyloplax* capture locations in wood-fall habitat off the Wairarapa coast.



Figure 4-8: *Xyloplax* specimens.

4.3.2 Biodiversity values

General values:

Molluscs (including chitons and gastropods) are the principal taxonomic group represented on deep-sea wood, followed by crustaceans, polychaetes and echinoderms. The fauna is frequently closely related to the fauna encountered around hydrothermal vents, cold seeps, and whale falls. However, sunken-wood ecosystems remain poorly known compared with these other deep-sea ecosystems and it has only been since the 1970s that intensive studies have been carried out, often opportunistically. Like whale falls, wood-falls are reducing environments and the organic substrate undergoes a prolonged decay process during which a diverse range of organisms comes to be associated with it (Kiel & Godert 2006; Bernardino et al. 2010; Samadi et al. 2010).

Xyloplax species are known from only three regions in the world and are rare globally. Samples from the Wairarapa coast are associated with a range of other remarkable organisms in the same habitat. Whereas sea daisies inhabit the borings made by shipworm, other wood-associated animals live on the surface or in furrows, feeding on bacterial- and fungal-mediated decaying cellulose and other wood products and the biofilms associated with them (Palacios et al. 2006). These include limpets of the families Cocculinidae (*Coccopigya hispida*) and Pseudococculinidae (*Tentaoculus haptricola*, *Colatrachelus hestica*) (Marshall 1985) and tiny snails of the family Skeneidae (*Bathyxylophila excelsa*, *Dillwynella lignicola*, *D. haptricola*, *Hyalogyrina glabra*, *Leptogyra patula*, *Leptogyropsis kalinovoeae* and *Xyloskenea costulifera*) (Marshall 1988). *Coccopigya hispida* is itself host to an endemic monotypic genus and species of parasitic copepod, *Cocculinika myzorama*. The type (and only known) locality is off Castlepoint at 1,198–1,211 m (Jones & Marshall 1986).

The wood-fall sites off the Wairarapa coast are among the closest to the New Zealand mainland and have a high diversity of associated species. The depth range for all three Wairarapa collection sites of *Xyloplax* is within 1,110–1,208 m, suggesting the possibility of one or more sinks within the Wellington Region's CMA in which transported wood may be trapped. Videography of the underwater sites where sunken logs have been found would help to clarify the situation.

4.3.3 Habitat features relevant to criteria

Representativeness: – Wood-fall habitats are not presently represented in existing protected areas.

Rarity: – Deep-sea wood-fall habitats are known in New Zealand only from the Kermadec Trench, in the Bay of Plenty, and off the coast of Wairarapa, Kaikōura, Timaru and Hokitika, and on Mernoo Bank. Within the Wellington Region they have only been described at a few localities off the Wairarapa Coast but may exist elsewhere at depths between 1,110–1,208 m. The Cook Strait Canyon system is an obvious area to investigate.

Diversity: – The family Xyloplacidae is very rare nationally and internationally and in New Zealand known otherwise only from the Hokitika Canyon. Species are habitat-dependent. The parasitic copepod *Cocculinika myzorama* is so far known only from its type locality off Castlepoint on sunken wood.

4.3.4 Threats – present and future

The main threat is probably trawling which removes or disturbs the sunken wood habitat. Anything that prevents a continuous supply of wood material from adjacent coasts may have an impact on these populations.

4.3.5 Existing status and levels of protection

None. Wood-falls are ephemeral and unable to be protected although the habitats in which they occur may be able to be protected as part of measures to ensure representation of marine ecosystems.

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5 Synthesis

This report has provided additional information on eight sites and three habitats of significant marine biodiversity in the CMA of the Wellington Region (Table 1.1, Appendix A). The sites range from intertidal sea grass on the Wairarapa coast to methane seeps lying in 1,100 m of water at the south-east extremity of the region. One of the sites, the Kāpiti Island rhodolith beds, lies partly inside an existing protected area. All other sites are currently unprotected.

Kelp bed habitat is partly protected within the western and eastern marine reserves around Kāpiti Island and the Taputeranga Marine Reserve along Wellington City's south coast but the other habitats are currently unprotected except the narrow exclusion zone around the Cook Strait DC power cable, and the 270 km² exclusion zone around the explosives dumping ground in the eastern Cook Strait marine area (i.e., these effectively serve as de facto marine protection zones offering protection from bottom trawling). There is current international focus on the health of kelp ecosystems, and on the impacts of climate and human-mediated modifications on marine species and habitats and consequential ecosystem impacts. Baseline data for New Zealand remain scarce and there is no systematic monitoring on which to evaluate health, and any changes in status and trends. The monitoring by the citizen science groups established by the Wellington Underwater Club, *Project Baseline Wellington Harbour*, provides data on the population at one *Macrocystis* bed within Wellington Harbour (Miller 2020, Appendix B). In addition, the application of machine learning to surveying kelp assemblages provides new approaches to coastal monitoring (D'Archino et al. 2019, 2020).

As noted by MacDiarmid et al. (2012a, b) the coastal marine sites and habitats identified in the Wellington Region as having significance for biodiversity are threatened by a range of human activities. The awareness of the impacts of global climate change, and how these are, and will be, experienced at a local level, is increasing (Salinger et al. 2019; Sutton & Bowen 2019; Chiswell & Sutton 2020).

The CMA within the Wellington Region is being affected by the fast-changing climate. A recent study (Sutton & Bowen 2019, Figs 1, 2 and 4) detected a water temperature rise at a number of stations in the New Zealand ocean region, including the Wairarapa Coast. The Sutton and Bowen (2019) paper noted that NOAA OI SST (sea surface temperature) temperature products used in the study are in good agreement with in-situ coastal temperature records whereby offshore SSTs accurately reproduced the variability at the coastal sites for interannual timescales. The agreement was particularly good for sites along open coasts but deteriorated for sites in harbours and enclosed waters. The rate of water temperature increase over the past three decades is +0.32 °C/decade, which is substantially above the global ocean average of around 0.06 °C/decade and more than triple global air temperature trends of ~0.1 °C/decade (Sutton & Bowen 2019).

The trend can be traced back over the last three decades. Over shorter timescales, the increasing trend in water temperature in the region is lower than the average (Chiswell & Sutton 2020, Fig. 3), which highlights the need to consider sustained observations over climatic timescales. Although the extremes of recent marine heatwaves (i.e., summer boosts of several degrees) will be mitigated by strong ocean mixing in Cook Strait, warming trends are affecting much of the upper ocean and the underlying trend is having an impact on all continental shelf waters.

Salinger et al. (2019) identified a range of biological impacts that occurred during a single marine heatwave (the summer of 2017/18), one being the exceedance of the thermal tolerance of locally

dominant kelp species. In addition, they referred to anecdotal information that suggested tropical and warm-temperate fish were more common, and that “commercial fishers trawling for snapper (*Pagrus auratus*) in the north of the South Island since 1981 estimated the species had spawned six weeks earlier than normal”.

Foley and Carbines (2019) developed a sensitivity matrix for key aquatic habitats and species in the Auckland Region. Based on average projections, they considered this to be a more conservative approach for assessing sensitivity than using the maximum potential change. As they note, variability in future conditions is likely to be high, and “the frequency, magnitude, and duration of extreme events are likely to be more important than average conditions in determining the sensitivity of aquatic ecosystems to climate change”. In Table 5-1, we have used this matrix approach to estimate impacts on the sites and habitats of significance addressed in this report to six known categories of impacts of climate change using our expert knowledge and a previous expert assessment (MacDiarmid et al. 2012b).

Table 5-1: Sensitivity matrix for key sites and habitats of significance for marine biodiversity in the Wellington Region (treated in this report) to the direct effects of climate change. (after Foley & Carbines 2019).

Degree of sensitivity	Water temperature	Extreme rainfall	Sediment	Nutrients	Ocean Acidification	Sea level rise
<i>Adamsiella</i> beds	High	Moderate	High	High	Moderate	Moderate
Horse mussel beds	High	Moderate	High	Moderate	High	Moderate
Rhodolith beds	High	Low	High	High	High	Moderate
Anemone beds	High	Low	High	Moderate	Moderate	Low
Intertidal seagrass	High	High	High	High	Moderate	Moderate
Shelf canyons	Moderate	Low	Low	Low	High	Low
Methane seeps	Low	Low	Low	Low	Moderate	Low
<i>Macrocystis</i> forests	High	Moderate	High	High	Moderate	Moderate
Kelp beds	High	High	High	High	Moderate	Moderate
Deep sea wood-falls	Low	Low	Low	Low	Low	Low
Seamounts	Low	Low	Low	Low	Moderate	Low

The sites and habitats identified as containing significant marine biodiversity in the Wellington Region vary widely in the amount of information available to define their habitat features relevant to the biodiversity evaluation criteria. While the Opuawe Bank methane seeps are well studied, many of the other sites and habitats remain poorly known. Focused investigations are likely to reveal much relevant information.

6 Information gaps for sites and habitats of significance for indigenous marine biodiversity in the Wellington Region

In the preparation of this report the need for further research and/or summaries of additional information have become apparent.

Adamsiella beds: The areal extent of the beds in Evans Bay has been surveyed, and it has been found that this bed supports a high macroalgal biomass with a diverse associated biota. It is not known, however, whether there are seasonal fluctuations in the macroalgae and associated fauna making up the assemblage within the bed. The vulnerability of the beds and the component species to human-induced change, particularly impacts of sedimentation (particularly associated with activities in and around Evans Bay) and climate impacts also have not yet been established.

Horse mussel bed: The horse mussel bed identified during the 2021 survey in Evans Bay is documented for the first time but has yet to be fully characterised. The role of the horse mussels as ecosystem engineers in the Wellington Harbour, and their vulnerability to human induced changes are not known.

Rhodolith beds: The distribution and density of the rhodolith beds at Kāpiti remain to be documented. There is also a need to understand the associated biota – macroalgae, in- and epi-fauna as well as cryptofauna, to establish whether these beds are serving as biodiversity hotspots as has been postulated. The response of the rhodoliths and their associated biota to human-induced changes also needs investigation, in particular to establish whether there needs to be further protection or mitigation of any current practices or activities that may be having deleterious impacts.

Anemone beds: Investigations are needed to understand the distribution and density of the anemone beds, and associated biota. Given such assemblages have not been documented previously in the New Zealand region research on their ecology, phenology and physiology (in particular in relation to key climate change stressors) is warranted.

Mataikona seagrass: Although there have been reports of these patches for ca 50 years, the distribution and extent of these beds is undocumented. It is not known if these seagrass areas vary seasonally or inter-annually and the degree of connectivity between patches. Impacts of local stressors need to be evaluated (such as local sources of sedimentation and impacts of roading, etc), as well as general impacts related to climate change (e.g. temperature impacts, frequency and intensity of storm events).

Shelf edge canyons and Methane seeps: For both of these sites, impacts associated with fishing, particularly bottom trawling and dredging, are currently the main threat to seafloor fauna. Summaries of fishing effort for trawling, set netting and long lining within the relevant portions of the CMA would enable a clearer picture of activities that have occurred historically and are currently underway and provide context for decisions about protection measures.

Cook Strait seamounts: While there is information available about the benthic communities on seamount 310, there is no data for seamount 516. The latter seamount, which has a shallow peak in the photic zone, is a relatively rare type of seamount feature in New Zealand waters. Surveying the benthic communities of this seamount would be useful to confirm, or otherwise, its potential biodiversity and ecological significance. This seamount is fished recreationally.

Kelp Habitats and *Macrocystis* beds: The international evidence strongly points to the vulnerability of habitat-forming large brown algae to changing climate, particularly changes in temperature (both increases in mean temperature and heat waves). Kelps are also vulnerable to indirect impacts of fishing and interactions of predators and herbivores. There are no baseline data about the extent of *Macrocystis* in the Wellington region as well as the other major habitat-forming species, nor research on their vulnerability within the Wellington region to the key local and global stressors. The research using machine learning for surveying kelp beds including observations of seasonal and interannual changes, that has been initiated by D'Archino et al., offers potential as a cost-effective tool for monitoring and evaluation of change. The acquisition of baseline data will enable evidence-based management and potentially enable mitigation of local stressors.

7 Acknowledgements

We wish to acknowledge the input of Greater Wellington Regional Council staff including Megan Oliver, Pam Guest, and Megan Melidonis, as well as Helen Kettles (DOC). We thank the members of the Kāpiti Mapping Group, in particular, Jonathan Gardner (VUW) and Shane Geange (DOC), for permission to use material from their research. We thank Dennis Gordon and Craig Stevens for expert advice, Malcolm Clark for information on seamounts, Sadie Mills for biological data from *niwainverts* (all NIWA), Brent Wood for assistance with mapping of the Evans Bay beds, Don Morrisey (Cawthron) for access to maps of Evans Bay, Nicole Miller for data from the Wellington Underwater Club Project Baseline, and Juliet Milne (NIWA) for reviewing the report.

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Appendix A Table of Scheduled sites and habitats and NZCPS vs RPS criteria

Regional Policy Statement Policy 23: Identifying indigenous ecosystems and habitats with significant indigenous biodiversity values - district and regional plans (must fit one or more of these criteria to qualify)	Representativeness: the ecosystems or habitats are typical and characteristic examples of the full range of the original or current natural diversity of ecosystem and habitat types in a district or in a region, and: are no longer commonplace (less than 30% remaining)	Representativeness: the ecosystems or habitats are typical and characteristic examples of the full range of the original or current natural diversity of ecosystem and habitat types in a district or in a region, and: are poorly represented in existing protected areas (less than about 20% legally protected)	Rarity: the ecosystem or habitat has biological or physical features that are scarce or threatened in a local, regional or national context. This can include individual species, rare and distinctive biological communities and physical features that are unusual or rare	Diversity: the ecosystem or habitat has a natural diversity of ecological units, ecosystems, species and physical features within an area	Ecological context of an area: the ecosystem or habitat enhances connectivity or otherwise buffers representative, rare or diverse indigenous ecosystems and habitats	Ecological context of an area: the ecosystem or habitat provides seasonal or core habitat for protected or threatened indigenous species
NZCPS Policy 11	Representativeness (1)	Representativeness (2)	Rarity	Diversity	Ecological Context – connectivity	Ecological Context seasonal or core habitat
a. avoid adverse effects of activities on:	<ul style="list-style-type: none"> i. indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists; ii. taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened; 					

NZCPS Policy 11	Representativeness (1)	Representativeness (2)	Rarity	Diversity	Ecological Context – connectivity	Ecological Context seasonal or core habitat
<p>iii. indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare;</p> <p>iv. habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare;</p> <p>v. areas containing nationally significant examples of indigenous community types; and</p> <p>vi. areas set aside for full or partial protection of indigenous biological diversity under other legislation; and</p>	<p>Anemone meadows; Outer Cook Strait seamounts</p>	<p><i>Adamsiella</i> beds; Horse mussel beds; Rhodolith beds; Anemone meadows; Mataikona seagrass; Shelf edge canyons; methane seeps; kelp beds; Wellington Harbour freshwater seeps; Porirua Harbour (Pauatahanui Inlet)</p> <p>Giant kelp beds (<i>Macrocystis</i>)</p>	<p><i>Adamsiella</i> beds; Horse mussel beds; Rhodolith beds; Anemone meadows; Mataikona seagrass; methane seeps; Giant kelp beds (<i>Macrocystis</i>); deep sea wood-fall; Wellington Harbour freshwater seeps; Porirua Harbour (Pauatahanui Inlet); Outer Cook Strait seamounts</p>	<p>Shelf edge canyons; methane seeps; Giant kelp beds (<i>Macrocystis</i>); Outer Cook Strait seamounts</p>		

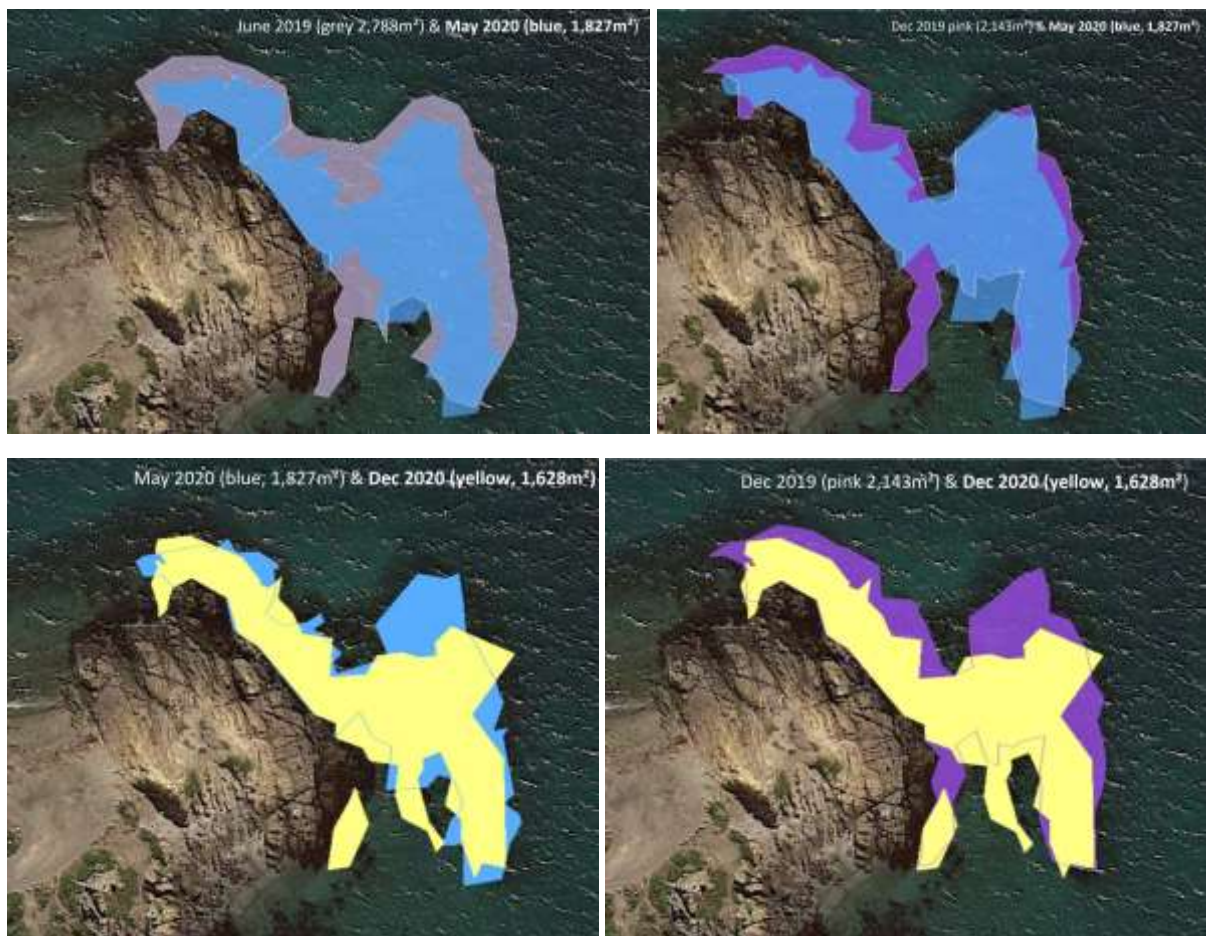
NZCPS Policy 11	Representativeness (1)	Representativeness (2)	Rarity	Diversity	Ecological Context – connectivity	Ecological Context seasonal or core habitat
<p>b. avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on:</p>	<p>i. areas of predominantly indigenous vegetation in the coastal environment;</p> <p>ii. habitats in the coastal environment that are important during the vulnerable life stages of indigenous species;</p> <p>iii. indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh;</p>			<p>Mataikona mixed algal assemblages; Kelp beds; rhodolith beds; Giant kelp beds (<i>Macrocystis</i>)</p> <p>Rhodolith beds; Horse mussel beds; kelp beds; subtidal reef habitat; Wellington habitat corridors</p> <p>Mataikona seagrass; Horse mussel beds; kelp beds; Mataikona mixed algal assemblages; subtidal reef habitat</p>	<p>Giant kelp beds (<i>Macrocystis</i>); Porirua Harbour (Pauatahanui Inlet)</p> <p>methane seeps; Giant kelp beds (<i>Macrocystis</i>)</p>	

NZCPS Policy 11	Representativeness (1)	Representativeness (2)	Rarity	Diversity	Ecological Context – connectivity	Ecological Context seasonal or core habitat
<p>iv. habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes;</p> <p>v. habitats, including areas and routes, important to migratory species; and</p> <p>vi. ecological corridors, and areas important for linking or maintaining biological values identified under this policy.</p>				<p>kelp beds; subtidal reef habitat</p>	<p>Wellington habitat corridors</p> <p>Wellington habitat corridors; kelp beds</p>	

Appendix B Project Baseline – citizen science observations

The Wellington Underwater Club started Project Baseline Wellington in 2016 with an initial qualitative survey in June 2016 around the Miramar Peninsula. Volunteer snorkelers and divers monitor the extent of giant kelp at Kau Bay in Wellington Harbour every six months. GPS data obtained by snorkelers swimming offshore around the floating fronds of *Macrocystis* are used to delimit the extent of the bed and to map and calculate the spatial area covered for each monitoring date. The smallest spatial extent was recorded in December 2016, whereas the largest extent for this bed was recorded in November 2017. Further information is presented in Miller (2020).

The maps below are examples of the data generated by Project Baseline Wellington, and the graph summarises the observations to date on the surface cover of the bed.



Giant kelp (*M. Pyrifera*) surface coverage at Kau Bay Point

