Biodiversity on Seamounts in Aotearoa

Katrina Goddard, October 2021

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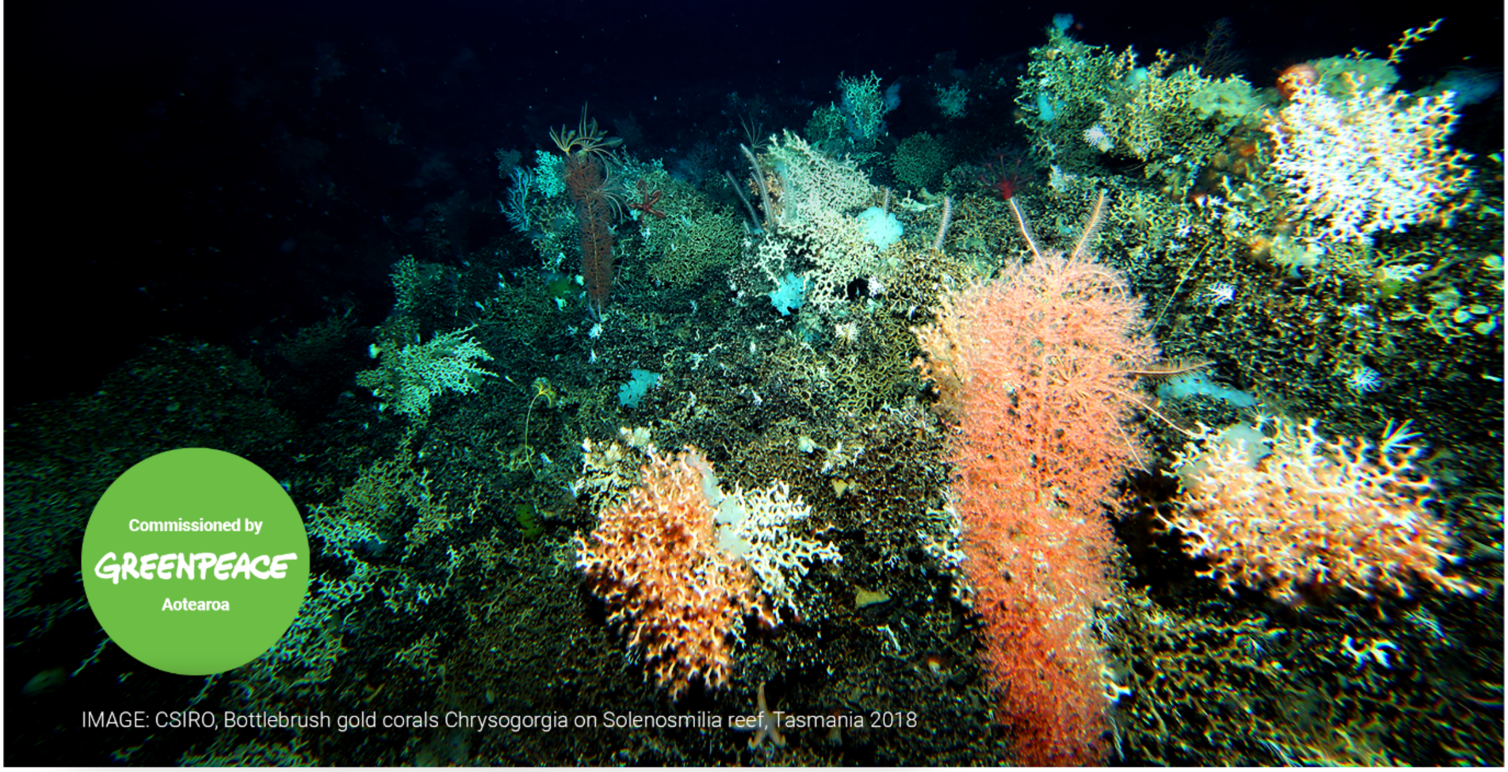

Commissioned by GREENPEACE Aotearoa

IMAGE: CSIRO, Bottlebrush gold corals Chrysogorgia on Solenosmilia reef, Tasmania 2018

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Author: Katrina Goddard
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Why seamount protection is critical

1. Seamounts are home to disproportionate amounts of biodiversity

Seamounts are underwater mountains that rise more than 100m off the seafloor[1] and are regarded globally as hotspots of marine biodiversity because they are home to many diverse, often unique, and endemic species or communities[2]. Only a fraction of Aotearoa's seamounts and associated biodiversity has been sampled or surveyed, and what is known is that Aotearoa seamounts can host abundant and diverse vulnerable marine ecosystems (VME) indicator species [3]. VME indicator species include rare and unique species, species that are functionally significant to the health of marine habitats and species which are particularly complex, slow growing or long lived[4]. Seamounts are important to migratory pelagic species like whales[5], sharks and even tuna[6]. There is international evidence that near sea-surface seamounts can also be important feeding grounds for different seabird species[7].

2. Thriving biodiversity underpins overall ocean health

The deep-sea constitutes the largest source of species and ecosystem diversity on Earth[8] as well as supporting diverse ecosystem processes and functions necessary for the Earth's natural systems to operate. Thriving healthy oceans including deep-sea ecosystems associated with seamounts and similar features build resilience against climate change[9]. The ocean is an important carbon store as it captures CO_2 from the atmosphere[10], absorbing around 25% of all CO_2 emissions[11]and then storing it.

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[1] Staudigel et al. 2010
[2] Ministry for the Environment and Statistics NZ, 2019
[3] NIWA, 2016
[4] Watling & Auster, 2021
[5] Garrigue et al. 2015
[6] Morato et al. 2010
[7] Iyer et al. 2012
[8] UNESCO, 2015
[9] Sweetman et al. 2017
[10] Bijma et al. 2013
[11] Watson et al. 2020

3. Healthy seamounts are critical for the long-term sustainability of fisheries

Seamounts are highly productive due to their physical hard structure providing substrate for species to grow on and live amongst[12], and level of nutrient rich upwellings which support high levels of plankton productivity which attracts a range of biodiversity[13,14]. Upwelled nutrients from the deep-sea fuel photosynthesis supporting major fisheries such as anchovies[15] and tuna[16]. Seamounts are also critical habitats, such as sites of spawning aggregations for some deep-sea fish species like orange roughy[17].

4. Damage done to seamounts is essentially irreversible

Seamount biodiversity, like protected corals are slow-growing and highly fragile making them highly vulnerable to bottom trawling especially given the core depth distributions of most protected corals[18] overlaps with the main 'fishable' depths. As few as ten individual bottom trawls can reduce deep-sea coral forests to rubble[19]. Research has shown that recovery of some deep-sea coral vulnerable marine ecosystems from the impacts of benthic impacting fishing methods is possible but will take several decades to centuries[20].

5. Existing protected areas do not adequately protect seamounts and associated biodiversity

Seventy two percent of seamounts (>100m) and similar features are unprotected and vulnerable to benthic fishing methods[21]. No type 1 MPAs (marine reserves) can be established beyond the territorial sea (12 nm) into the EEZ where the majority of seamounts occur. Existing benthic protected areas (BPAs) provide little protection as much of the seabed and features like seamounts are well beyond the current trawlable depths that extend to around 1,600 meters[22], and also the core-depth distribution of VME taxa, such as protected corals[23].

6. Bottom trawling is expanding into new unfished areas both in Aotearoa and beyond

While the commercial trawl footprint comparatively to a decade ago is smaller, new areas are still being trawled[24]. Within the SPRFMO area New Zealand is the only country currently bottom trawling on seamounts. New Zealand is still reporting high bycatch rates of VME indicator

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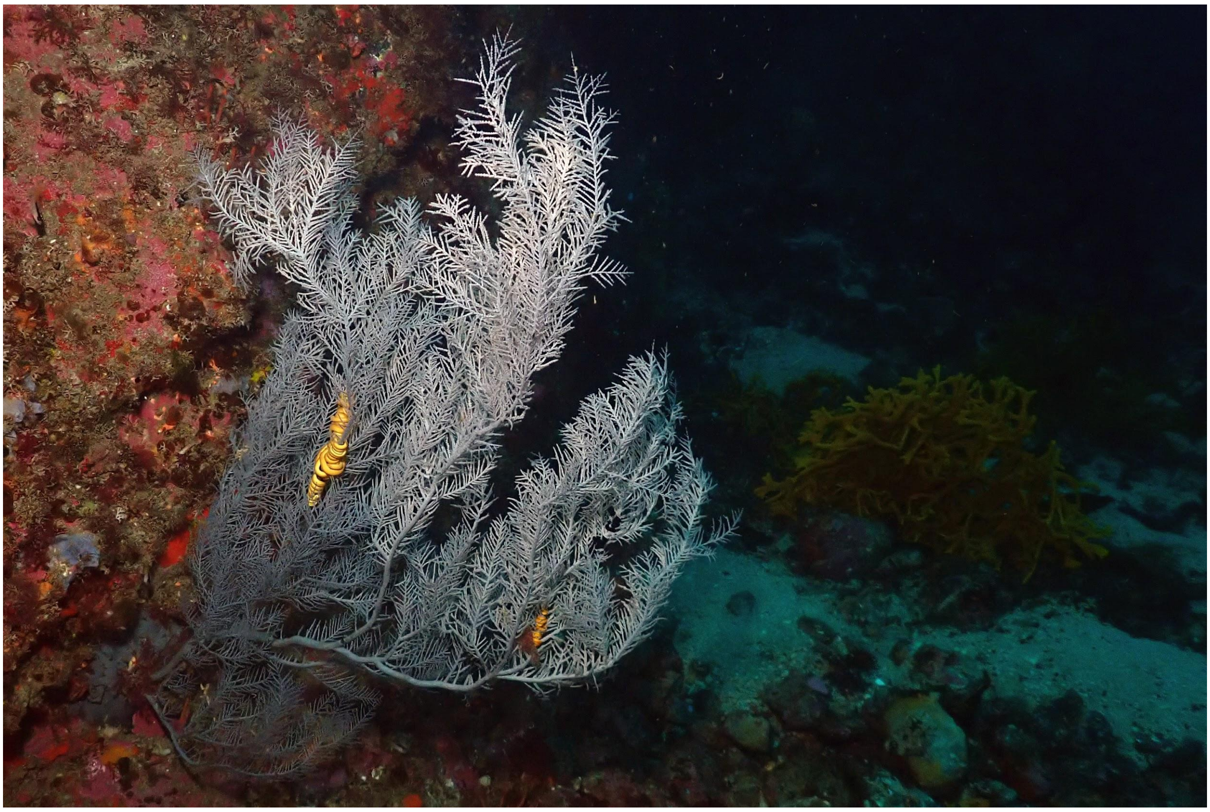
12 Schlacher et al. 2014
13 Annasawmy et al. 2020
14 Demarcq et al. 2020
15 Le & Sato, 2017
16 Morato, et al. 2010
17 Bull et al. 2001
18 Tracey & Hjorvarsdottir, 2019
19 Clark et al. 2010
20 Baco et al. 2019
21 Fisheries New Zealand, 2020
22 Maximum trawlable depth is about 1,600 m, from Tracey, 2018.
23 Tracey & Hjorvarsdottir, 2019
24 WWF-NZ, 2021

species to SPRFMO. Given scientists are discovering new deep-sea invertebrates from areas fished and unfished, it means there is the potential for New Zealand vessels to destroy endemic or rare invertebrate species before they can be discovered and identified.

7. Banning bottom trawling on seamounts is essential

Protecting all seamounts and similar features from all benthic impacting fishing methods will ensure Aotearoa's vulnerable marine ecosystems such as protected endemic, rare and diverse deep-sea corals not only survive but thrive. Protecting VMEs would also go some way towards New Zealand meeting its international obligations, such as United Nations General Assembly resolutions and domestic policies and legislation.



© Andy Stewart. Black coral, Hen & Chickens Islands, Northland New Zealand, 2021

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Section 1: Seamounts and similar features

In 2015 the first World Ocean Assessment stated that the deep-sea constitutes the largest source of species and ecosystem diversity on Earth[25]. The deep-sea also supports the diverse ecosystem processes and functions necessary for the Earth's natural systems to operate, yet despite this and the importance of the deep, only a tiny fraction of the deep-sea has ever been studied[26].

What are Seamounts and similar features?

Seamounts are undersea mountains often referred to as deep-sea biological 'hotspots' as they are highly productive areas[27]. Similar features include hydrothermal vents, which are underwater hot springs found on the ocean seafloor, often referred to as 'black smokers' or 'white smokers' depending on the minerals they produce. Other similar underwater topographic features are hills, knolls and guyots.

Despite there being no universally agreed definition of the term 'seamounts', seamounts are widely defined as undersea mountains that rise more than 100m from the surrounding seafloor[28, 29]. The Food and Agriculture Organisation of the United Nations (FAO) *generally*[30] defines seamounts as having an elevation of greater than 1,000m from the seafloor[31]. However, researchers have shown that the physical characteristics of seamounts and similar features less than 1,000m can affect biodiversity in similar ways to those greater than 1,000m above the seafloor[32,33,34].

In Aotearoa, the Department of Conservation (DOC) and Fisheries New Zealand (FNZ) agree that seamounts and similar features (including knolls and hills) are those that rise more than 100m above the seafloor[35]. In addition to Government agencies, the 100m elevation definition is widely used by New Zealand scientists at NIWA[36] and in international scientific publications. If the 1,000m definition was used in Aotearoa over the 100m then many seamounts and similar features would be excluded[37], such as the well studied Northwest hills seamount complex on the Chatham Rise. NIWA scientists have shown in Aotearoa it's not the height of the seamount, but the depth from the surface that influences the abundance and diversity of endemic, rare and vulnerable invertebrates like corals and sponges, as many protected corals have core depth

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[25] UNESCO, 2015

[26] UNESCO, 2015

[27] Ministry for the Environment and Statistics NZ, 2019

[28] Staudigel et al. 2010 defined seamounts as: "*any geographically isolated topographic feature on the seafloor taller than 100 m, including ones whose summit regions may temporarily emerge above sea level, but not including features that are located on continental shelves or that are part of other major landmasses*" See also Rogers, 1994 & Rogers, 2019.

[29] Kim,2014

[30] emphasis added

[31] FAO seamount definition: "*A large isolated elevation characteristically of conical form. Seamounts are under-sea mountains whose summits lie beneath the ocean surface. They are usually volcanic in origin and are* ***generally*** *defined as having an elevation of greater than 1 000 metres from the seabed*" from Cochrane, 2002 [emphasis added].

[32] Rogers, 2018

[33] Lyer et al. 2012

[34] Tracey & Hjorvarsdottir, 2019

[35] Department of Conservation & Fisheries New Zealand, 2021

[36] NIWA - National Institute of Water and Atmospheric Research is a New Zealand Crown Research Institute established in 1992

[37] Like the number of seamounts described by Rowden & Clark, 2004

distribution ranges of between 200 - 1,000m deep[38], meaning many protected corals are unable to live on the deeper seamounts, even those that have elevations over 1,000m as they are simply too deep.

Seamounts are usually volcanic in origin[39] and tend to occur in groups or chains but can also be isolated. Generally, most are found near convergent tectonic plates in areas of vertical movement [40]. Seamounts can vary significantly in height, from hundreds of meters to several kilometres in elevation off the seafloor[41]. Typically, seamounts have a steep outer slope, a near flat circular summit and often collapsed features such as calderas or pit caters[42,43]. Figure 1 shows a typical seamount from Aotearoa mapped using underwater seabed mapping technology by NIWA.

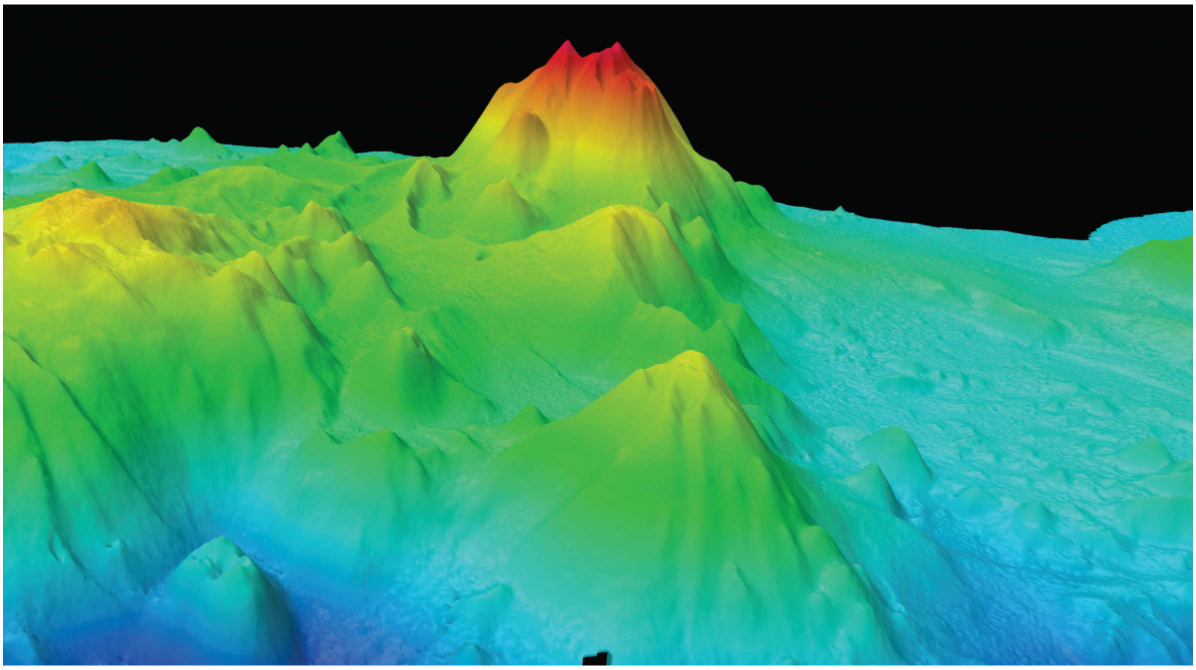

Figure 1: Hinepuia Seamount on the Kermadec Arc. Credit: NIWA[44]

Seamount Biodiversity & Productivity

Seamounts are regarded globally as hotspots of marine biodiversity because they are home to many diverse, often unique, and endemic species or communities[45]. These include corals, sponges and other sessile epifauna organisms[46]. It is estimated that only 0.002% of global seamounts have been sampled adequately, meaning our knowledge of seamount biological communities is very limited and it is highly likely many benthic communities and species are yet to be discovered[47].

[38] Tracey & Hjorvarsdottir, 2019
[39] Rogers, 2018
[40] Rogers, 2018.
[41] Lyer et al. 2012
[42] Lyer et al. 2012
[43] Rogers, 2018
[44] NIWA, 2013 Here be dragons | NIWA
[45] Ministry for the Environment and Statistics NZ, 2019
[46] Schlacher et al. 2014
[47] Rogers, 2018

Seamounts are highly productive due to their physical hard structure providing substrate for species to grow on and live amongst[48], disruption of ocean currents, and level of nutrient rich upwellings which support high levels of plankton productivity which attracts a range of biodiversity[49,50]. Seamounts are important to migratory pelagic species like whales, sharks and even tuna[51]. Seamounts are also critical habitats, such as sites of spawning aggregations for some deep-sea fish species like orange roughy[52] and even deep-sea eels, like basketwork[53].

Satellite tracking of endangered South Pacific humpback whales highlights that seamounts are not only important during migrations, but also during the breeding season, as tagged whales used oceanic seamounts frequently during both[54]. This study described the multiple ecologically important roles seamounts played – from breeding locations, resting areas, navigational landmarks and even likely supplemental feeding grounds[55].

There is international evidence that near sea-surface seamounts can be important feeding grounds for different seabird species, as areas surrounding these near surface seamounts have higher densities of seabirds than adjacent waters[56].

Upwelled nutrients from the deep-sea fuel photosynthesis supporting major fisheries such as anchovies[57] and tuna[58]. But deep-sea ecosystems don't only support extractive services like fisheries, they also play an important role in non-extractive services such as climate regulation[59].

Thriving healthy oceans including deep-sea ecosystems associated with seamounts and similar features build resilience against climate change[60]. The ocean is an important carbon store as it captures CO_2 from the atmosphere[61], absorbing around 25% of all CO_2 emissions[62]and then stores it. Carbon sequestration (the physical process of sinking biologically produced carbon from the upper ocean into the deep sea) is an important biological climate change mitigation pathway as it can store the CO_2 from the atmosphere[63] for thousands to millions of years[64].

Anthropogenic CO_2 emissions have resulted in ocean warming, deoxygenation, and acidification [65,66]. Research is limited looking at how global climate change will affect carbon sequestration and deep-sea ecosystems and their associated biodiversity such as reproduction, distribution, and

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48 Schlacher et al. 2014
49 Annasawmy et al. 2020
50 Demarcq et al. 2020
51 Morato et al. 2010
52 Bull et al. 2001
53 Williams et al. 2021
54 Garrigue et al. 2015
55 Garrigue et al. 2015
56 Iyer et al. 2012
57 Le & Sato, 2017
58 Morato, et al. 2010
59 Le & Sato, 2017
60 Sweetman et al. 2017
61 Bijma et al. 2013
62 Watson et al. 2020
63 UNESCO, 2015
64 Sabine et al. 2004
65 Thiagarajan et al. 2013
66 Sweetman et al. 2017

survival[67]. What is certain is that warming of deep-sea ecosystems will likely affect carbon sequestration (predicted to decline significantly[68]), and the survival and distribution of many species. For example, most deep-sea corals are slow growing, extremely long-lived and have evolved in a specialised and stable environment[69]. This means they are highly susceptible to ocean acidification and other anthropogenic climate change impacts[70,71], which could result in changes in their depth range distributions[72] (potentially become more restricted[73]) and could even cause some species to go extinct[74].

While deep-sea ecosystems are increasingly vulnerable from the impacts of climate change[75], they are also highly vulnerable to physical disturbance such as destructive bottom trawling and marine mining. These destructive methods break down these carbon stores as they can re-mineralise sedimentary carbon to CO_2 which could increase ocean acidification, reduce the buffering capacity of the ocean, and potentially add to the build-up of atmospheric CO_2[76].

Clark et al. (2010) found that as few as ten individual bottom trawls can reduce deep-sea coral forests to rubble[77]. This is important as it not only illustrates the impact trawling has had, but that trawling on new areas, even just a few times, can have catastrophic cumulative impacts to deep-sea benthic communities and ecosystem services.

The latest government data indicates that 14 tonnes of coral[78] was dragged up in bottom trawl nets in Aotearoa waters in a single year (2018-2019)[79]. Scientists estimate that only a small fraction of the coral that is smashed on the seabed by trawlers, actually makes it up to the surface in the net. For example, 250 kilograms of deep-sea corals brought up in the net indicates that 27-85 tonnes of corals were destroyed on the seabed[80].

International Obligations to Protect Vulnerable Marine Ecosystems, like Seamounts and similar features

The ecosystems associated with seamounts and other similar underwater features like hydrothermal vents are often referred to as vulnerable marine ecosystems (VMEs)[81]. This is because of the diverse and often unique species or communities that are associated with them,

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[67] Sweetman et al. 2017
[68] Sweetman et al. 2017
[69] Thiagarajan et al. 2013
[70] Thiagarajan et al. 2013
[71] Dijkstra et al. 2021
[72] Tracey & Hjorvarsdottir, 2019
[73] Thiagarajan et al. 2013
[74] Dijkstra et al. 2021
[75] Le & Sato, 2017
[76] Sala et al. 2021
[77] Clark et al. 2010 found that for New Zealand seamounts in depths of 700 - 1,000m as few as 10 trawls could eliminate corals from 15 to 20% cover to no visible cover.
[78] This estimate is based on the Department of Conservation's calculated figures for observed coral bycatch per 100 trawls and is based on just under 20% observer coverage. The squid fishery and deep-water bottom trawl fisheries (orange roughy, cardinal and oreo) accounted for 85% of the observed coral bycatch. Source: Weaver, 2020
[79] Weaver, 2020
[80] Pitcher et al. 2019. From this ratio, 1 mt in the net equates to 108 - 340 mt on the seabed
[81] Food and Agriculture Organization, 2009 Note VMEs are described on FAO website Vulnerable Marine Ecosystems | Food and Agriculture Organization of the United Nations (fao.org)

referred to as indicator species (or communities[82]). VME indicator species have specific life characteristics, primarily that they are long-lived and are easily damaged by physical disturbance, such as fishing gear due to their physical and functional fragility, such as corals, sponges and other epifauna[83].

© Paul Caiger. Gorgonian fan (Alcyonacea), Poor Knights Islands, New Zealand 2020

The UN Convention on the Law of the Sea (UNCLOS) sets out the obligations of States[84] to protect, conserve and manage the ocean. Part XII of UNCLOS[85], including Article 192 and Article 194(5) imposes on states a general obligation to protect and preserve the marine environment as well as more specific obligations relating to the protection and preservation of rare or fragile ecosystems and the habitat of depleted, threatened, or endangered species. Such species and habitats include corals[86].

The United Nations Fish Stocks Agreement[87] provides for obligations to implement the precautionary approach (Article 6), protect ecosystems and protect biodiversity (Article 5(g)). The United Nations General Assembly (UNGA) resolutions have addressed the impacts of fishing on VMEs in international waters, with specific reference to seamounts, hydrothermal vents, and cold-water corals.

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82 Watling & Auster, 2021
83 Watling & Auster, 2021
84 State / Country - referring to a political unit that has sovereignty over an area of territory and the people within it. UN Member States can be found here: [Member States | United Nations]
85 UNGA resolution 59/25, paragraphs 66-71. Adopted 2004
86 DSCC, 2021
87 United Nations, 1995. The UN Fish Stocks Agreement

In 2004[88] and 2006 UNGA adopted resolutions calling for urgent action to protect seamounts and other VMEs in international waters. States and Regional Fisheries Management Organisations (RFMOs) were urged to "*implement measures, in accordance with the precautionary approach, ecosystem approaches and international law*" by the end of 2008 or else prohibit bottom fishing on the high seas VMEs. Resolution 61/105 (2006)[89] required specific measures including prior impact assessments, identifying VMEs and closing them or otherwise protecting them, and requiring vessels to stop fishing when they encounter a VME by bringing up deep-sea coral and/or other indicator species in their nets (the "move-on rule")[90].

These UNGA resolutions and FAO guidelines for seamount protection in international waters were established because of the crucial importance of seamounts. In 2009 the UNGA reviewed the measures that had been taken to protect deep-sea biodiversity and concluded that more needed to be done by States to implement the 2006 resolution.

New Zealand has also committed in Aichi Target 6 that by 2020 "*fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems*"[91], and committed in Sustainable Development Goal 14 to Target 14.2: "*By 2020 sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience and take action for their restoration, to achieve healthy and productive oceans*"[92].

More recently, the UN General Assembly has declared the period 2021-2030 as the Decade on Ecosystem Restoration for preventing, halting and reversing the degradation of ecosystems worldwide[93].

Aotearoa Obligation to Protect Vulnerable Marine Ecosystems, like Seamounts and similar features

New Zealand not only has these international obligations to implement within Aotearoa's Exclusive Economic Zone (EEZ[94]) but has domestic legislation and policies to protect biodiversity and avoid, remedy or mitigate against adverse fishing effects on seamounts and similar features.

Key legislation, policies and fish plans include the Fisheries Act 1996, Wildlife Act 1953, Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012, Te Mana o te Taiao, the Aotearoa New Zealand Biodiversity Strategy 2020 and the Deepwater Fish Plan.

Additional legislations and policies such as the Marine Protected Areas Policy and the Marine Reserves Act 1971 are relevant when it comes to protecting areas, which could include seamounts and similar features if they are located within the territorial waters (0-12nm). Beyond 12 nm, outside of the territorial seas to the EEZ (200 nm offshore) marine reserves cannot be established. Benthic protection can be put in place using provisions in the Fisheries Act or via special legislation.

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88 UNGA resolution 59/25, paragraphs 66-71. Adopted 2004.
89 UNGA resolution 61/105, paragraphs 76-87. Adopted 2006.
90 DSCC, 2021
91 Convention on Biological Diversity (cbd.int)
92 Goal 14: Life Below Water | The Global Goals
93 UN Decade on Restoration
94 The EEZ extends 200 nautical miles from the coast of New Zealand (including the coast of all islands)

The Fisheries Act 1996

The Fisheries Act 1996 does not explicitly require or provide for an ecosystem-based approach to be applied to fisheries management. The purpose under Section 8 is "*to provide for the utilisation of fisheries resources while ensuring sustainability*".

Ensuring sustainability is defined as meaning under s8(2)[95]:

(a) "*Maintaining the potential of the fisheries resources to meet the reasonably foreseeable needs of future generations*", and

(b) "***Avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment***"[96]

Utilisation is defined as meaning under s8(2)[97] *"means conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural well-being"*

Section 9 of the Fisheries Act describes the environmental principles[98] that are to be taken into account when decisions are made by the Minister for Oceans and Fisheries:

(a) "Associated or dependent species should be maintained above a level that ensures their long-term viability"

(b) "Biological diversity of the aquatic environment should be maintained"[99]

(c) "Habitat of particular significance for fisheries management should be protected"

Section 10 of the Fisheries Act describes the four information principles[100] to be taken into account:

(a) "Decisions should be based on the best available information"

(b) "Decision-makers should consider any uncertainty in the information available in any case"

(c) "Decision-makers should be cautious when information is uncertain, unreliable, or inadequate"

(d) "The absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of the Fisheries Act"

As stated in the High Court ruling[101] "*the purpose of the Act to provide for the utilisation of fisheries resources while ensuring sustainability (Fisheries Act Section 8)" "As the Supreme Court said in New Zealand Recreational Fishing Council Inc v Sanford Ltd (Supreme Court Kahawai case)*[102]"

> "*Section 8(1) appears in Part 2 of the Act headed "Purpose and principles". It expresses a single statutory purpose by reference to the two competing social policies reflected in the Act. Those competing policies are "utilisation of fisheries" and "ensuring sustainability". The meaning of each term in the Act is defined in s 8(2). The statutory purpose is that both policies are to be accommodated as far as is practicable in the administration of fisheries under the quota management system. But recognising the*

[95] Fisheries Act 1996 No 88 (as at 01 April 2021), Public Act Contents – New Zealand Legislation
[96] [emphasis added]
[97] Fisheries Act 1996 No 88 (as at 01 April 2021), Public Act Contents – New Zealand Legislation
[98] Fisheries Act 1996 No 88 (as at 01 April 2021), Public Act Contents – New Zealand Legislation
[99] [emphasis added]
[100] Fisheries Act 1996 No 88 (as at 01 April 2021), Public Act Contents – New Zealand Legislation
[101] *Royal Forest and Bird Protection Society of New ZealandIncorporated v Minister of Fisheries [2021]*NZHG 1427
[102] New Zealand Recreational Fishing Council Inc v Sanford Ltd [2009] NZSC 54, [2009] 3 NZLR 438 [Supreme Court Kahawai case]

inherent unlikelihood of those making key regulatory decisions under the Act being able to accommodate both policies in full, s 8(1) requires that in the attribution of due weight to each policy that given to utilisation must not be such as to jeopardise sustainability. ***Fisheries are to be utilised, but sustainability is to be ensured****"*[103, 104].

Court rulings confirm fisheries utilisation is not a balance or a trade off made against sustainability by the Minister but that "*sustainability is to be ensured*" and as such must be prioritised. To date s 8(2)(b) and s 9 have not been applied adequately to protect seamounts and similar features and the VMEs (biodiversity) associated with them as the Act has not ensured that "*biological diversity of the aquaculture environment should be maintained*" and that adverse effects of fishing on the aquatic environment are avoided, remedied or mitigated. In Aotearoa waters under the Fisheries Act a commercial fishing vessel can destroy an unlimited amount of VME taxa or indicator species, such as protected corals while legally bottom trawling[105]. This is inconsistent with international law, with the Law of the Sea Convention in Article 192 requiring that *"States have the obligation to protect and preserve the marine environment*." and in Article 194(5) requiring measures "*necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life*".

New Zealand regulations are weaker than those in place in international waters regarding the amount of VME indicator species such as corals, that can be destroyed by New Zealand flagged commercial fishing vessels[106]. Within the EEZ there is no "move-on rule", which would require a vessel to move one nautical mile away from where it was trawling if a certain amount of VME indicator taxa is caught, which is the case for example in the South Pacific[107] where New Zealand flagged vessels fish.

Under the Fisheries Act, in 2007 32% of Aotearoa's EEZ[108] across a number of areas were closed to bottom trawling and dredging, these are known as benthic protected areas (BPAs). These BPAs have been widely criticised for lacking in scientific basis related to their biodiversity value or species representativeness[109,110]. The areas were largely chosen by the commercial fishing industry and 72% of these BPAs are waters deeper than two kilometres[111]. This means most of these BPAs are well beyond the current trawlable depths that extend to around 1,600 meters[112], and also the core-depth distribution of VME taxa, such as protected corals[113].

A small fraction of Aotearoa's seamounts and associated biodiversity has been surveyed and benthic taxa described meaning there is no way to accurately determine how much biological diversity loss has occurred due to the effects of benthic fishing. There is no requirement to take a

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[103] [emphasis added]
[104] New Zealand Recreational Fishing Council Inc v Sanford Ltd [2009] NZSC 54, [2009] 3 NZLR 438 [Supreme Court Kahawai case]
[105] As long as the Wildlife Act 1953 regulations are followed
[106] Discussed further in Section 2
[107] South Pacific Regional Fisheries Management Area
[108] Ministry for Primary Industries, 2021 Benthic Protected Areas Benthic protection areas | Fishing and aquaculture | NZ Government (mpi.govt.nz)
[109] Rieser et al. 2013
[110] Leathwick et al. 2008
[111] Leathwick et al. 2008
[112] Maximum trawlable depth is about 1,600 m, from Tracey, 2018.
[113] Tracey & Hjorvarsdottir, 2019

precautionary approach. If Section 9 included the precautionary approach and required management decisions to be guided by this, it could help give effect to these principles, as this would ensure that the lack of full scientific certainty is not used as a reason not to act to prevent further environmental and biodiversity degradation and loss.

Under Section 11[114] or Section 297(1)(a)(vii)[115] of the Fisheries Act 1996 the Minister could regulate bottom trawling and ban it on seamounts and similar underwater features within Aotearoa. If such closers were put in place to meet s 8(2)(b) and s9 principles this would not reduce the amount of the allocated quota (TAC or specifically the TACC) for any affected fish stocks. These can only be adjusted using s 13 – total allowable catch of the Fisheries Act.

Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 regulates the environmental effects of mineral mining activities (and other seabed activities) beyond the territorial sea and has a specific requirement that when certain marine consents are considered the consent authority must take into account under Subpart 2D – Decision Section 59(2)[116] the following[117]:

> *"59(2)(a) any effects on the environment or existing interests of allowing the activity, including—*
>
> > *(i) cumulative effects; and*
> >
> > *(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and*
>
> *59(2)(d)* ***the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes***[118]
>
> *59(2)(e)* ***the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species***[119] *"*

Wildlife Act 1953

The Wildlife Act 1953 outlines the protection and control of wild animals and birds and the management of game. Schedule 7A[120] lists the marine species that are protected[121]. In 2010 the Act was amended to protect four coral groups in Aotearoa, these are:

- black corals (all species in the order Antipatharia)

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114 Section 11 –allows the Minister to set a sustainability measure and Section 11(3) allows the Minister to limit areas where a stock can be caught and fishing methods used. Section 297(1)(a)(vii) allows for regulating or prohibiting any method of fishing

115 Section 297 – general regulations. Allows for regulating or controlling fishing, specifically (vii) "*regulating or prohibiting any method of fishing"*

116 Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 No 72 (as at 08 September 2018), Public Act 59 Marine consent authority's consideration of application – New Zealand Legislation Note emphasis added to demonstrate particularly relevant statement for seamounts and similar features and their VME and associated biodiversity

117 Not all 59(2) is listed, the following are relevant towards seamounts and similar features and their associated biodiversity (VMEs).

118 emphasis added

119 emphasis added

120 Schedule 7A: Wildlife Act 1953 No 31 (as at 07 August 2020), Public Act – New Zealand Legislation

121 Non-coral protected marine species: oceanic whitetip shark, basking shark, deepwater nurse shark, white pointer shark, whale shark, manta ray, spinetail devil ray, giant grouper & spotted black grouper

- gorgonian corals (all species in the order Gorgonacea)
- stony corals (all species in the order Scleractinia)
- hydrocorals (all species in the family Stylasteridae)[122]

The protection status means it is illegal to deliberately collect, harm or kill these animals, but under Section 63B a permitted commercial fisher can destroy and kill any protected coral species while fishing in Aotearoa's waters, as long as they record the event and report it in writing within 48 hours (or as soon as practicable) and return the protected coral to the sea immediately[123].

The current Wildlife Act is inadequate as it does not protect these coral groups from being destroyed. It also only protects these specific coral groups, so if new species of corals (outside of those groups listed) are discovered within Aotearoa, they would not have a protection status.

Te Mana o te Taiao, the Aotearoa New Zealand Biodiversity Strategy 2020

Te Mana o te Taiao, the Aotearoa New Zealand Biodiversity Strategy (ANZBS) was updated and released in 2020. ANZBS "*sets a strategic direction for the protection, restoration and sustainable use of biodiversity, particularly indigenous biodiversity, in Aotearoa New Zealand*"[124]. ANZBS has the following objectives that agencies need to give effect to, including in advice to Ministers:

- *"By 2025, the number of fishing-related deaths of protected marine species is decreasing towards zero for all species."*
- *"By 2030 the direct effects of fishing do not threaten protected marine species populations or their recovery."*
- *"Zero non-target mortality by 2050 and marine fisheries resources are abundant, resilient and managed sustainably to preserve ecosystem integrity".*

Bottom trawling on seamounts and similar features where VMEs occur is not compatible with ANZBS.

National Fisheries Plan for deepwater and Middle-depth Fisheries 2019

The National Deepwater Fisheries Plan for Deepwater and Middle-depth Fisheries (Deepwater Plan) is a Fisheries New Zealand (FNZ) Plan that sets "*management objectives, actions, and services required to meet relevant legislative obligations and strategic directions for managing New Zealand's deepwater fisheries*"[125].

The Deepwater Plan has four specific environmental outcomes:

- *"Ensure that maintenance of biological diversity of the aquatic environment and protection of habitats of particular significance for fisheries management are explicitly considered in management*
- *Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on associated or dependent and incidentally caught fish species*
- *Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the benthic habitat*
- *Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the long-term viability of endangered, threatened and protected species populations"*

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[122] Schedule 7A: Wildlife Act 1953 No 31 (as at 07 August 2020), Public Act – New Zealand Legislation
[123] Unless part of an observer collection program
[124] The New Zealand Government, 2020.
[125] Fisheries New Zealand, 2019

The Deepwater Plan has specific management action for each objective, the most relevant is "*Explore the role of protecting marine biodiversity as a strategy to build the resilience of marine ecosystems and fish stocks to buffer the effects of climate change*". The Deepwater Plan does not have any specific management actions to reduce benthic impacts on protected, endangered or threatened VME taxa like corals.

©NIWA. Flabellum knoxi (endemic cup coral species)

Section 2: Overview of seamounts and similar features biodiversity found in Aotearoa

Aotearoa has over 800 known[126] seamounts within the EEZ greater than 100m high[127]. Most vary in water depth, height, geological origin, age, and level of primary productivity[128]. Figure 2 shows the locations of all known seamounts[129] and existing benthic protection, and Figure 3 is an example of an Aotearoa seamount complex.

[126] FNZ has commissioned the project BEN2020-07 to update the NZ database of all known seamounts and seamount-like features exceeding 100m elevation above the seafloor. Greenpeace requested a copy of the interim results (locations of the seamounts) of this project to include in this report but was denied. We have been advised the report will be published in January 2022.
[127] Rowden & Clark, 2004
[128] Rowden & Clark, 2004
[129] While this is 2008 it was the most recent data Greenpeace could access from Rowden et al, 2008, seamount table supplied by NIWA via email.

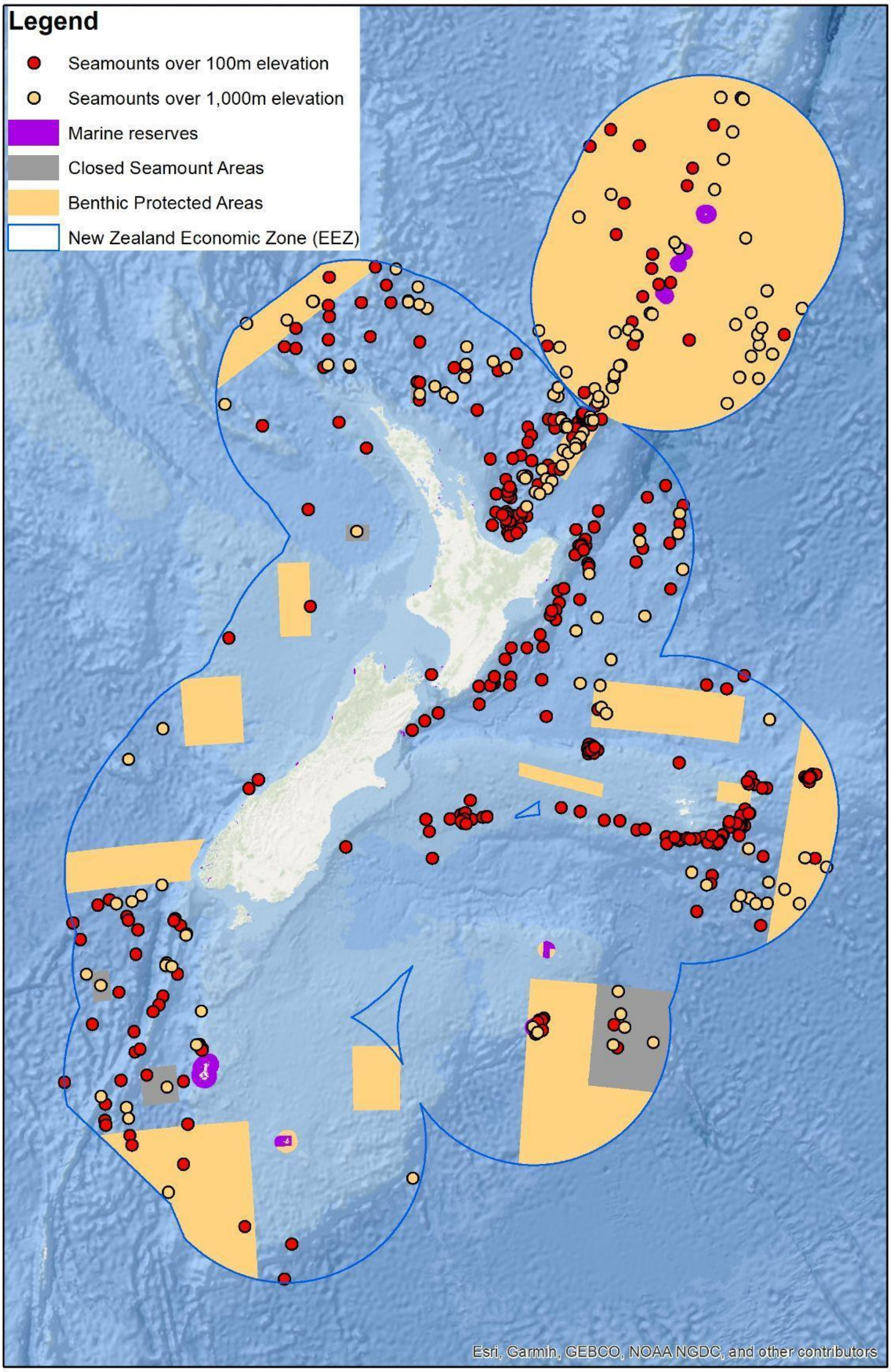


Figure 2: Location of known seamounts within Aotearoa that have a 100m or higher elevation (red) and a 1,000m or higher elevation (orange), along with existing benthic closures . Sources Rowden et al, 2008; Clark, 2021; New Zealand Government, 2021a,b & c.

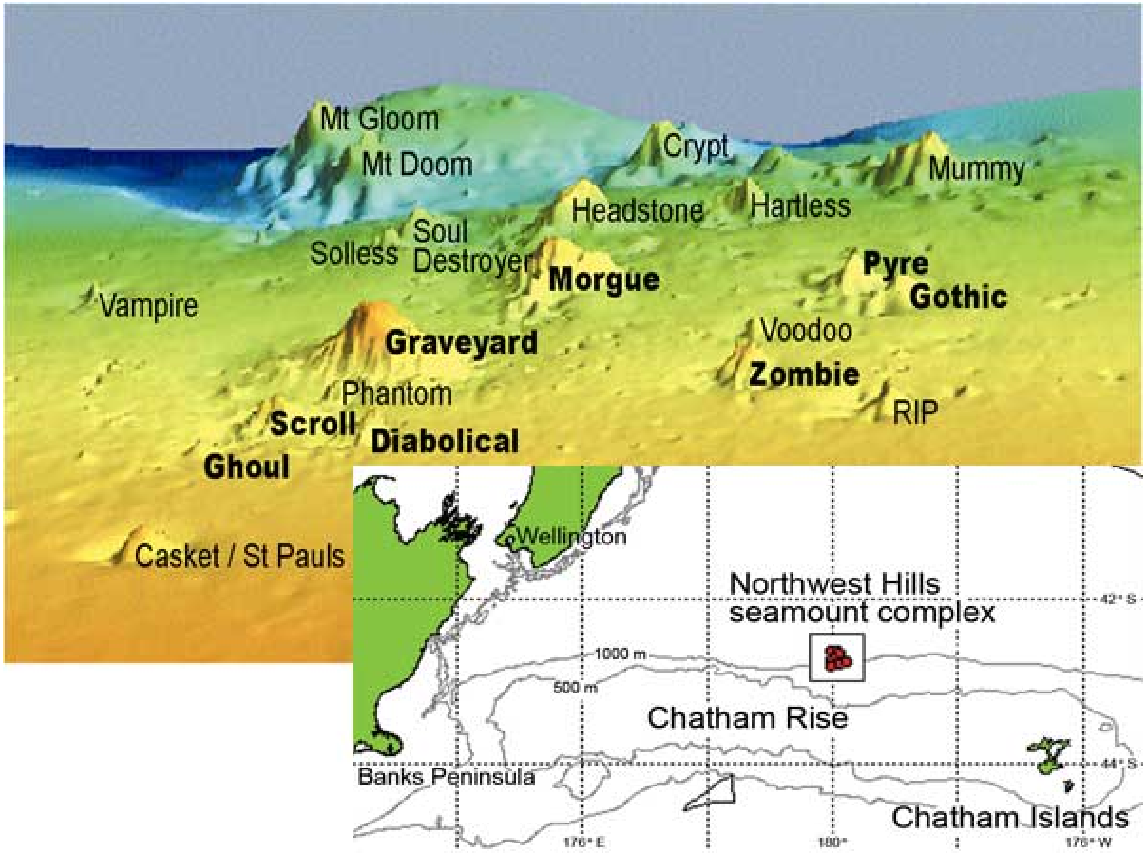


Figure 3: Shows the Northwest Hills seamount complex, located approximately 500 km east of Kaikoura and about halfway to the Chatham Islands. The seamounts in bold have been surveyed in detail and are between 100–400m high, rising from the seafloor at about 1,200m depth. Source: Clark, 2008

Benthic invertebrate biodiversity overall within Aotearoa is still poorly described[130]. However, Watling and Auster (2017) reviewed seamount data and the presence of VME indicator species from the South Pacific[131] and found that "*all seamounts that have so far been surveyed by cameras, either towed or mounted on maneuverable submersible vehicles, have been found to have abundant VME indicator species (including xenophyophores on sandy areas) distributed on their sides and summits*"[132]. This reinforces the assumption that all seamounts that occur within the biological depth ranges of VME indicator species, like deep-sea corals, should be considered to contain VMEs and therefore warrant full protection in order to meet New Zealand's domestic policies and international commitments.

NIWA has mapped the locations of VME in the wider South Pacific[133]. Figure 4 shows the known locations of VMEs within Aotearoa's EEZ.

[130] Clark et al, 2019b
[131] Including camera tows from some of the Louisville Seamounts from Clark et al, 2015
[132] Watling and Auster, 2017
[133] NIWA, 2016 Data available via OBIS

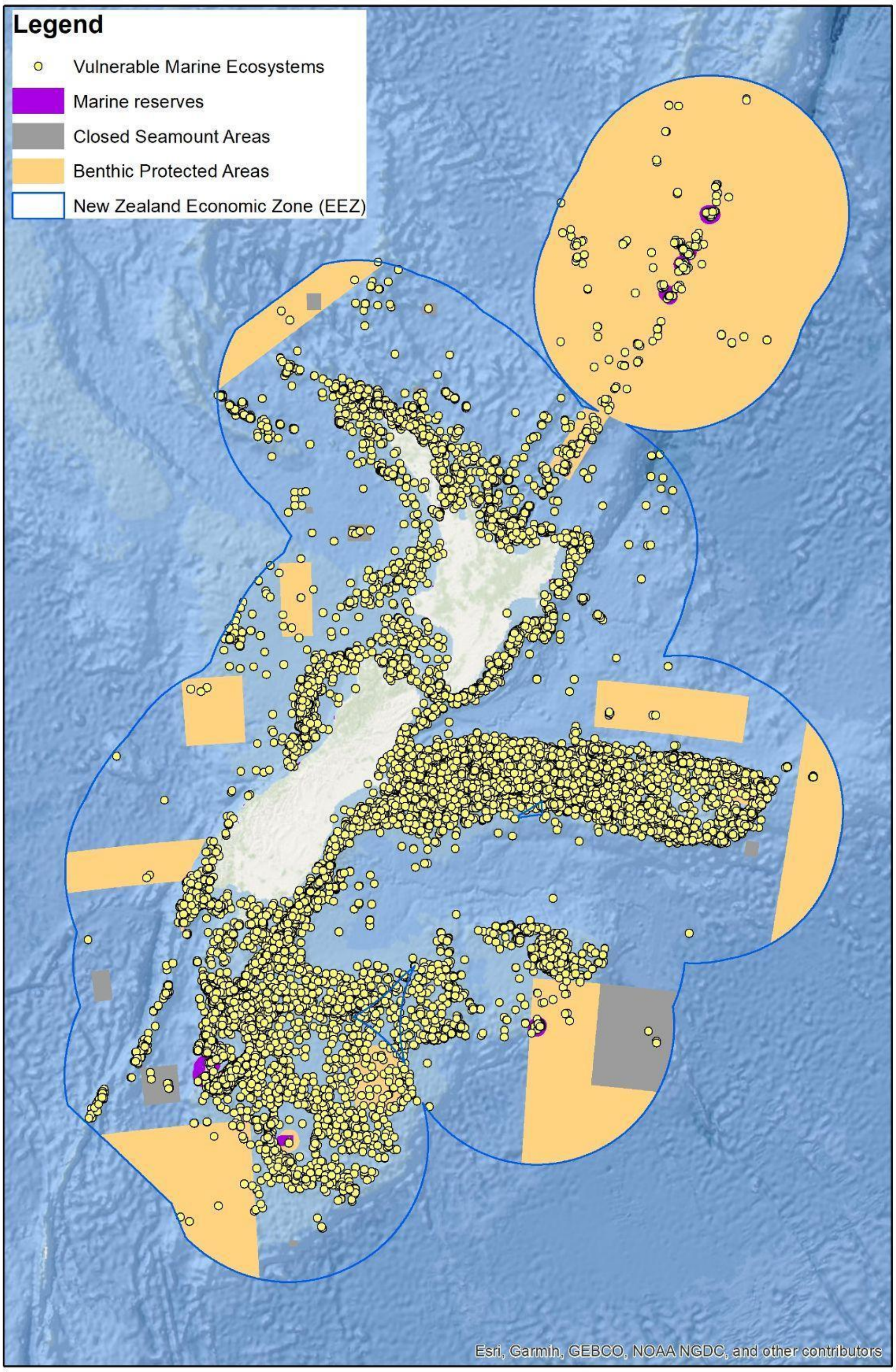


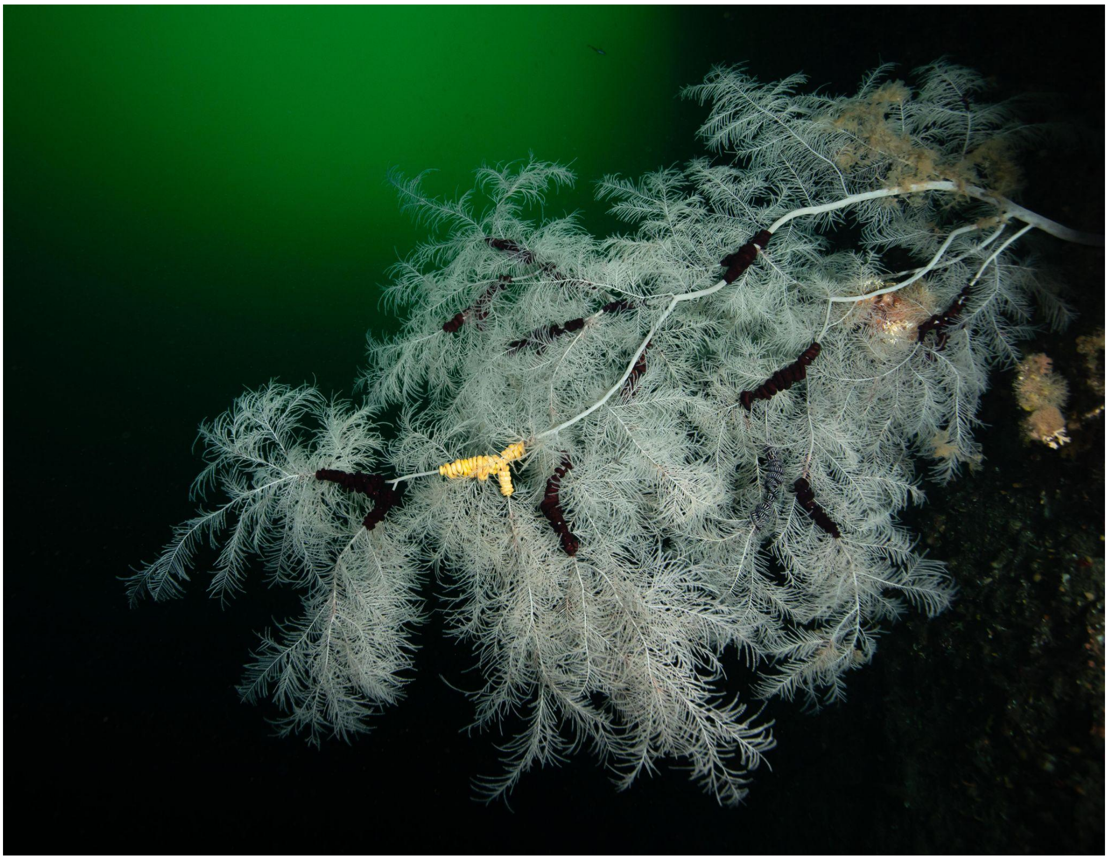
Figure 4: Location of known VMEs within Aotearoa's EEZ, also showing existing benthic protection (closures). Source: NIWA, 2016 & New Zealand Government, 2021a,b&c.

Deep-sea corals

Aotearoa's deep-sea cold-water corals are diverse, often unique[134,135]and are a key component of Aotearoa's deep-sea ecosystems[136]. Deep-sea corals are important as they can form biogenic hotspots that provide habitat, sanctuary, and nursery areas for many associated species, including various invertebrates and fish, including orange roughy and deep-sea cardinal fish species[137].

Deep-sea corals are mostly slow growing, have low natural mortality, can have short dispersal distances, and display extreme longevity[138], some even reaching thousands of years[139,140,141].

Scientists have aged many coral samples from Aotearoa, for example black coral Antipathari from the Chatham Rise taken at a depth of 870m was aged between 909 – 2,672 years old[142], and bubblegum coral *Paragorgia arborea* was aged between 300 – 500 years old[143]. These aging studies confirm that many deep-sea coral 'forests' have been growing for hundreds to thousands of years, and this is important given a few bottom trawls can wipe out entire coral communities or 'forests'.



© Paul Caiger. Black coral (Antipathella fiordensis), Dusky Sound, Fiordland, New Zealand 2021

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134 Holland et al. 2020
135 Bilewitch & Tracey, 2020
136 Clark et al., 2010
137 Rowden & Clark, 2004
138 Consalvey et al. 2006
139 Tracey & Hjorvarsdottir, 2019,
140 Marriott et al., 2020
141 Hitt et al., 2020
142 Hitt et al., 2020; Tracey & Hjorvarsdottir, 2019
143 Tracey et al. 2003 described by Tracey and Hjorvarsdottir, 2019

Endemism

There is evidence of extensive coral endemism within the waters around Aotearoa[144]. Table 1, taken from Tracey & Hjorvarsdottir (2019) summarises the state of knowledge of endemic coral species within Aotearoa's EEZ based on Cairns *et al* in Gordon 2009. It's important to note that this table has only been partially updated and that a full literature review is needed. The table does not include recent unpublished benthic invertebrate research commissioned by Fisheries New Zealand, which may have identified an undescribed (and unprotected) new coral species, which could be potentially endemic[145]. Regardless, what Table 1 shows is that Aotearoa has at least 196 known endemic coral species, and this number will definitely increase.

Table 1: Summary of endemic coral species from Aotearoa EEZ updated in part (from Cairns et al. in Gordon 2009; Opresko pers. comm). Source: Tracey & Hjorvarsdottir, 2019 (Table 2).

Taxon Cnidaria	Described living species	Known undescribed, undet. species	Estimate unknown species	Endemic species	Endemic genera
Anthozoa	279	270	140	~111	5
Alcyonacea	46	166	70	~58	4
Pennatulacea	12	19	5	0	0
Scleractinia	124	5	10	16	4
Corallimorpharia	5	0	3	2	0
Antipatharia	28	~80	~52	~20	1
Hydrozoa	454	28	75	121	7
Leptothecata	234	14	30	77	2
Anthoathecata	138	12	20	43	5
Total	**~1320**	**~594**	**~363**	**~196**	**~28**

Research has also demonstrated that Aotearoa's seamounts are incredibly unique as the assemblages of macroinvertebrates (like corals and sponges etc.) can be distinct from neighbouring seamounts separated by relatively small distances (tens of kilometres)[146]. This means a small area of ocean with several seamounts could have entirely unique and even endemic macroinvertebrate communities.

Protected deep-sea coral distributions

Not all corals are protected in Aotearoa, only the four groups listed under schedule 7A of the Wildlife Act 1953[147] are. The protection status means it is illegal to deliberately harm or kill these animals, but under Section 63B a permitted commercial fisher can destroy and kill any protected coral species while fishing in Aotearoa's waters, as long as they record the event and report it in writing within 48 hours (or as soon as practicable), and return the protected coral to the sea

144 Tracey and Hjorvarsdottir, 2019

145 Schnabel et al. (2019) [Unpublished Final Research Report for Fisheries New Zealand Project DAE2018-04, from Schnabel et al. 2021] states that scientists "*reported for the first time the zoanthid genus Bullagummizoanthus in the New Zealand region with two samples identified from the EEZ*" and that work is "*underway to determine whether the New Zealand specimens belong to an undescribed species*" Schnabel et al. 2021.

146 Rowden and Clark, 2004

147 Schedule 7A: Wildlife Act 1953 No 31 (as at 07 August 2020), Public Act – New Zealand Legislation

immediately[148]. The current Wildlife Act is inadequate as it does not protect these coral groups from being destroyed and it excludes any other groups of corals such as hexacorals Zoanthia as they are not listed on schedule 7A.

Protected corals groups:

- black corals (all species in the order Antipatharia)
- gorgonian corals (all species in the order Gorgonacea)
- stony corals (all species in the order Scleractinia)
- hydrocorals (all species in the family Stylasteridae)

The following deep-sea coral diversity and distributions are described based primarily on the review by Tracey and Hjorvarsdottir (2019)[149], but also Consalvey et al. (2006), Owen et al. (2016), Baird, et al.(2013), Tracey et al. (2011), Bilewitch and Tracey (2020a) and (2020b) and Owen et al. (2020).

A large majority of the information used to underpin our understanding of deep-sea coral diversity (such as species identification) and distributions comes primarily from observed bycatch samples from commercial deep-sea fisheries (such as bottom trawling for orange roughy). Additional data sources include limited research trawls or underwater surveys, such as those carried out on seamounts by scientists.

The level of reporting from un-observed commercial vessels is often poor and unreliable[150]. Consequently, the only source of accurate information comes from observed vessels bycatch. The problem with this is that coverage across all New Zealand vessels and locations (known as fisheries management areas (FMAs)) can be highly variable ranging from 0% coverage to 100% [151], and this data is not generally available to the public[152].

Table 2 shows the variation in observer coverage (percentage of fishing effort observed) and the total reported protected coral bycatch for the latest published fishing year (2018-2019). The squid trawl fishery had the highest observed coral bycatch in the 2018/19 fishing year with over 8,000kg of coral. The deep bottom trawl fisheries (orange roughy, cardinal and oreo species) were reported to have 526.9kgs of coral bycatch based on a total of 24.8% observer coverage.

[148] Unless part of an observer collection program
[149] Tracey et al. 2019 (Chapter 12)
[150] A camera trial in the Hauraki Gulf found that inshore fishers report twice as many protected seabirds captures when a camera was on board Source: Tremlay-Boyer & Abraham, 2020. Similar patterns of increased reporting of endangered, protected, or threatened species by commercial fishers when observers are present have been found in other New Zealand fisheries.
[151] FNZ is transitioning some fisheries within New Zealand to use electronic monitoring (cameras), once implemented this program should increase New Zealand's coverage.
[152] Observed bycatch data of protected species is reported by DOC in an annual Conservation Services Program report (Weaver, 2020), but the data is grouped, not spatially specific, not available in real time, and not publicly available. The author requested a copy of all the observed bycatch of protected species data broken down by fisheries and location in order to map it. This protected species observed bycatch data is not held by DOC but by FNZ. This request was turned into an Official Information Request and has not been delivered at the time of publishing this report.

Table 2: Summarises the latest report on observed protected coral bycatch in Aotearoa for the 2018/19 fishing year. All data comes from Weaver (2020)[153]

Fishery	Observer coverage[154]	Reported total protected coral bycatch for fishery (kgs)
Middle depth trawl fisheries (hoki, hake, ling and warehouse species)	Range: 0 - 41.4% Total: 31%[155]	45.9
Scampi	Range: 0 – 17.7 %[156] Total: 14.3%	135.7
Squid	Range: 0 – 93.6%[157] Total: 82.4%	8,015.7
Pelagic trawl fisheries (mackerel and barracouta)	Range: 0 – 95.4%[158] Total: 48.2%	11
Deepwater bottom trawl fisheries (orange roughy, cardinal and oreo species)	Range: 0 – 59.2%[159] Total: 24.8%	526.9
Inshore trawl	Range: 0 – 57.2%[160] Total: 4%	6
Inshore bottom longline	Range: 0 – 12.2%[161] Total: 3.3%	4
Precision Seafood Harvesting	Range: 0 – 100%[162] Total: 15.3%	138.2

Even the limited observer bycatch data can under-estimate the diversity of deep-sea coral species as not all observers are capable of accurately identifying deep-sea coral bycatch to a species level while at sea, not all bycatch comes back to shore for genetic testing or expert identification, and consequently we do not know what levels of endemism or cryptic benthic diversity exists in Aotearoa waters.

Bilewitch & Tracey (2020) genetically analysed 91 bycatch specimens of gorgonian corals and was able to identify viable DNA data for 62 specimens which led to a minimum of 34 different species to be identified[163]. This study found their "*rate of discovery of unique species indicates that many more species remain unsampled and that we have not yet documented the limits of gorgonian coral diversity within the sampled bycatch communit*y"[164]. Based on genetic analysis, this study found the orange roughy fishery alone had "*at least 23 species of protected gorgonian coral*" bycatch. Bilewitch & Tracey (2020) also concluded that "*we would expect similarly high numbers within the smooth oreo fishery as well, if*

[153] Note at the time of finalising this report in early October the latest CSP bycatch report had not been released and requests for the latest information were denied. We note this report was released Wednesday 27th October but was unable to be included.
[154] Range depends on the coverage within different locations / FMAs. Total is the overall observer coverage of fishing effort for the whole fishery. Note zero reflects that some trawls / lines in some FMAs did not have any observer coverage
[155] Weaver, 2020 Table 1.
[156] Weaver, 2020 Table 7
[157] Weaver, 2020 Table 10
[158] Weaver, 2020 Table 13
[159] Weaver, 2020 Table 16
[160] Weaver, 2020 Table 22
[161] Weaver, 2020 Table 34
[162] Weaver, 2020 Table 43
[163] Bilewitch & Tracey, 2020a
[164] Bilewitch & Tracey, 2020a

additional bycatch was sampled to the same extent as for orange roughy"[165]. This review highlights that many species of gorgonian octocoral are yet to be discovered and described from within Aotearoa[166].

NIWA has a significant invertebrate database which can be used to highlight the locations of known VMEs[167] (Figure 4) and the specific distributions of some protected corals. But given the nature of the deep-sea, it isn't possible to survey all seamounts and similar features to determine the diversity and location of VME indicator species, like protected coral species. NIWA scientists have developed a habitat suitability model based on key protected coral taxa to predict where they are likely to occur. This habitat suitability model has multiple applications and was used to predict the present and future distributions of 12 protected coral taxa[168]. Owen et al. (2020) found there was variability among the 12 coral taxa in the overlap of predicted distributions with current bottom trawling effort. Owen et al. (2020) found the taxa currently most vulnerable to trawling based on the habitat suitability modeling are the thicket-forming corals *Goniocorella dumos*a and *Madrepora oculata*, and the hydrocorals *Errina* species and *Stylaster* species[169].

Stony Corals:

Aotearoa has about 110 known anthellate (lacking symbiotic algae) stony corals (Order Scleractinia). These branching deep-sea corals are predominantly found between 800m – 1,200m water depth (Figure 5,) and are widely distributed around Aotearoa (Figure 6)[170]. To date no branching stony corals are listed as endemic, however there are various deep-sea stony cup corals that are endemic to Aotearoa that belong to the genus Flabellum[171]. Figure 7 shows the known distribution of cup corals from the Family Flabellidae and shows that they are widely distributed throughout Aotearoa's known seamounts.

Stony corals found in some regions such as the Chatham Rise are known to have unique genetic diversity[172]. This is likely because of the prevailing currents that converge from both the north and the south and the isolation of these stony coral populations[173].

165 Bilewitch & Tracey, 2020a
166 Bilewitch & Tracey, 2020a
167 NIWA, 2016
168 Owen et al. (2020)
169 Owen et al. (2020)
170 Tracey & Hjorvarsdottir, 2019
171 Tracey & Hjorvarsdottir, 2019
172 Holland et al. (2020)
173 Holland et al. (2020)

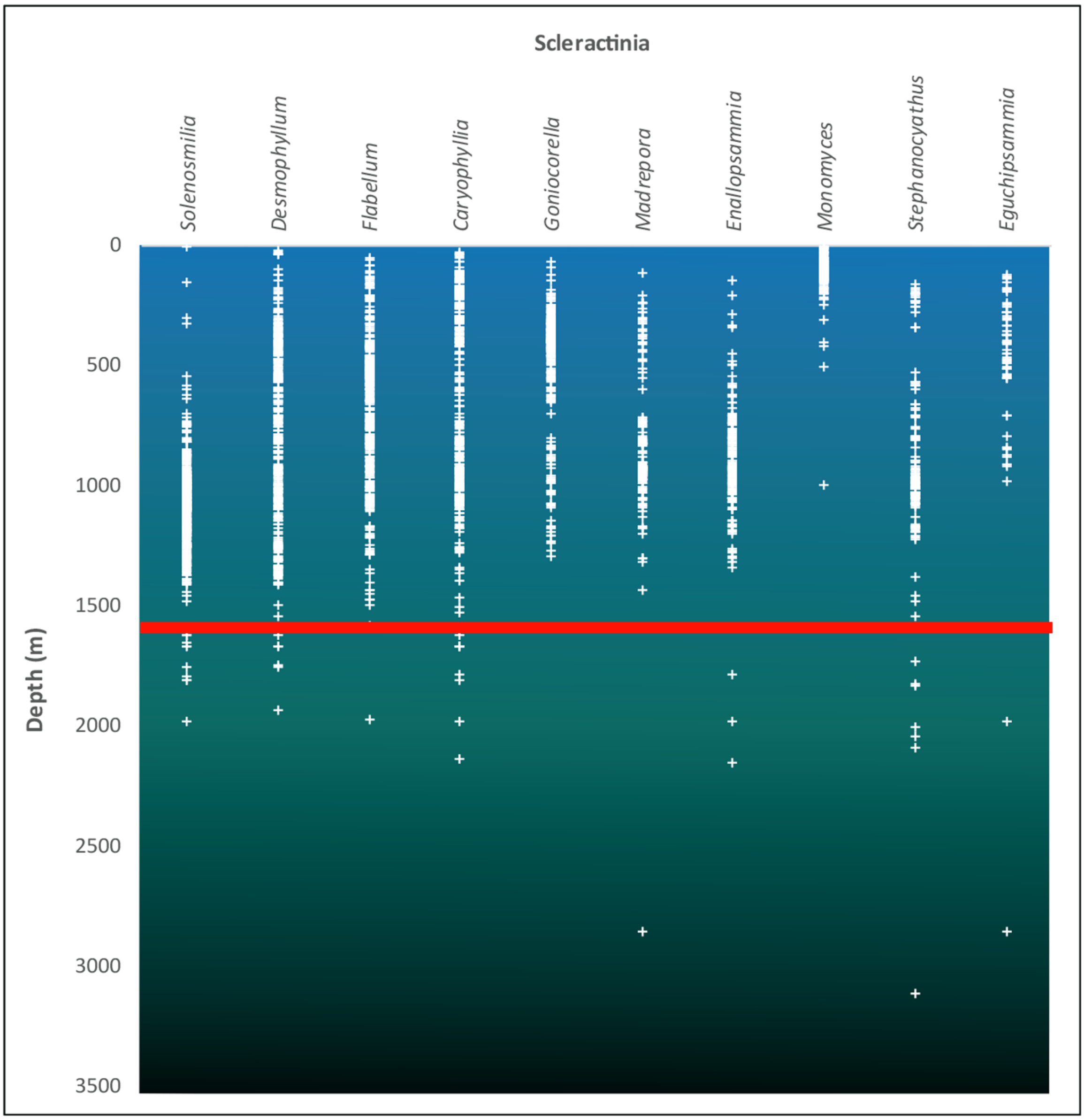


Figure 5: Depth distribution plot of the most abundant reef-forming and cuplike scleractinian stony corals. Source: Tracey & Hjorvarsdottir, 2019[174]. The red line represents the maximum depth New Zealand deep-sea trawlers operate, 1,600m (generally deep-sea trawlers operate between 200m - 800m)[175].

[174] Figure 30

[175] Fisheries New Zealand, 2020

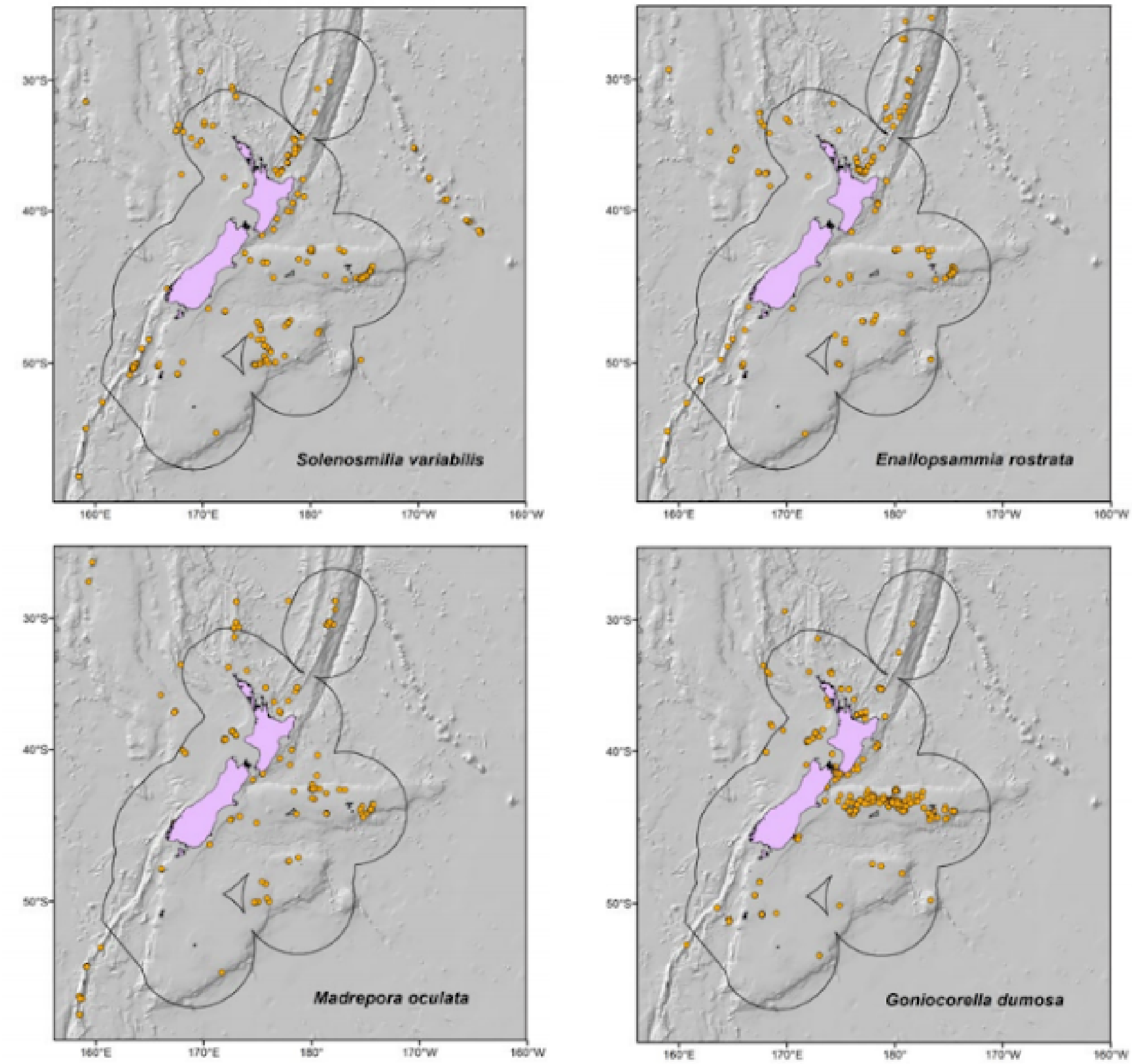


Figure 6: Distribution maps of four key habitat-forming branching stony corals (Scleractinia) found in Aotearoa waters. Published as supplementary material in Anderson et al. (2016). Source Tracey & Hjorvarsdottir, 2019[176]

[176] Figure 18

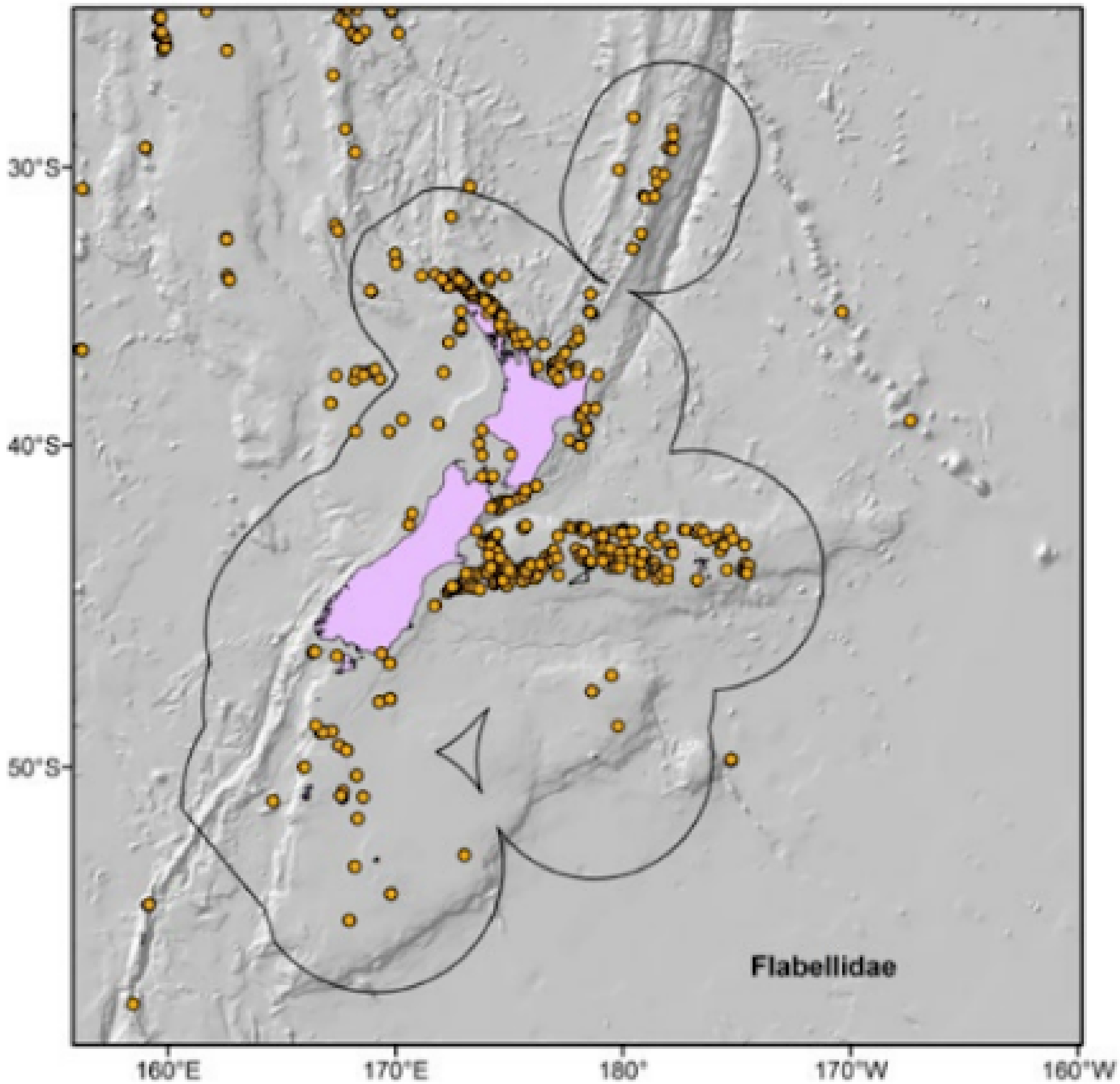


Figure 7: Distribution map of cup coral Family Flabellidae. Published as supplementary material in Anderson et al. (2016). Source Tracey & Hjorvarsdottir, 2019[177]

[177] Figure 34

©NIWA. Flabellum knoxi (endemic cup coral species), New Zealand

Black corals:

Aotearoa is known to have about 80 species of black corals (Order Antipatharia), of which seven have recently been described as new to science[178]. Black corals are widely distributed and found throughout the EEZ (Figure 8). Black corals are predominantly found between 200 – 1,000m deep, however some species are known to live deeper over 2,000m deep (Figure 9)[179].

It is not known how many black coral species are endemic. Scientists estimated that approximately 20 will be identified as endemic once all the new species and samples have been fully described[180]. A genetic review of some bycatch samples of black coral (*Bathypathes patula*) in Aotearoa in 2020 found that what was thought to be a single species was in fact a cryptic complex of at least five different genera[181]. It is highly likely that Aotearoa has more unknown species of black coral and that some of these will be endemic and located on seamounts and similar features.

178 Opresko, 2016 described in Tracey & Hjorvarsdottir, 2019
179 Tracey & Hjorvarsdottir, 2019
180 Tracey & Hjorvarsdottir, 2019
181 Bilewitch & Tracey, 2020b

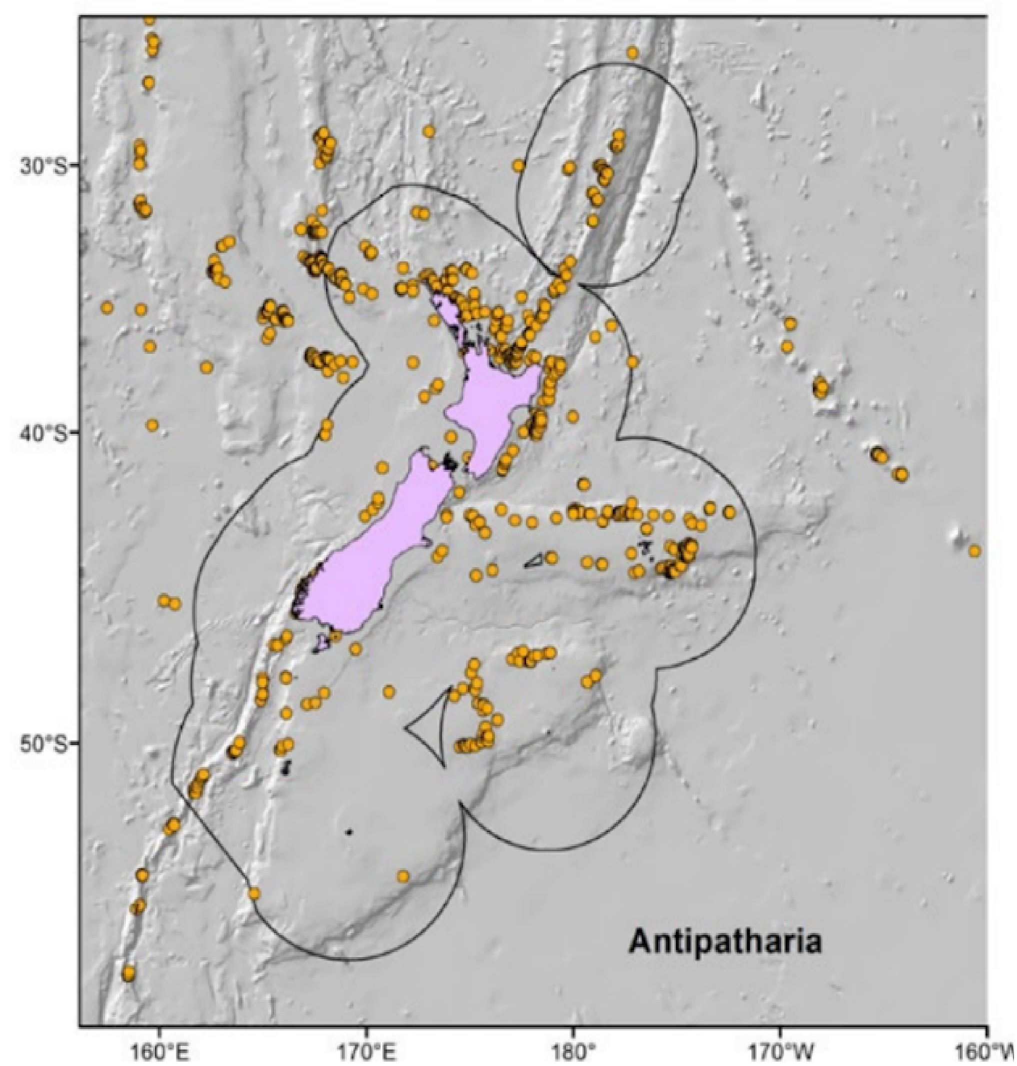


Figure 8: Distribution map of black coral group Antipatharia. Published as supplementary material in Anderson et al. (2016). Source Tracey & Hjorvarsdottir, 2019[182]

[182] Figure 36

© Greenpeace / Roger Grace, 2004.Protected black coral retrieved from bycatch from a deep-sea trawler in international waters 350 miles west of New Zealand in the Tasman Sea.

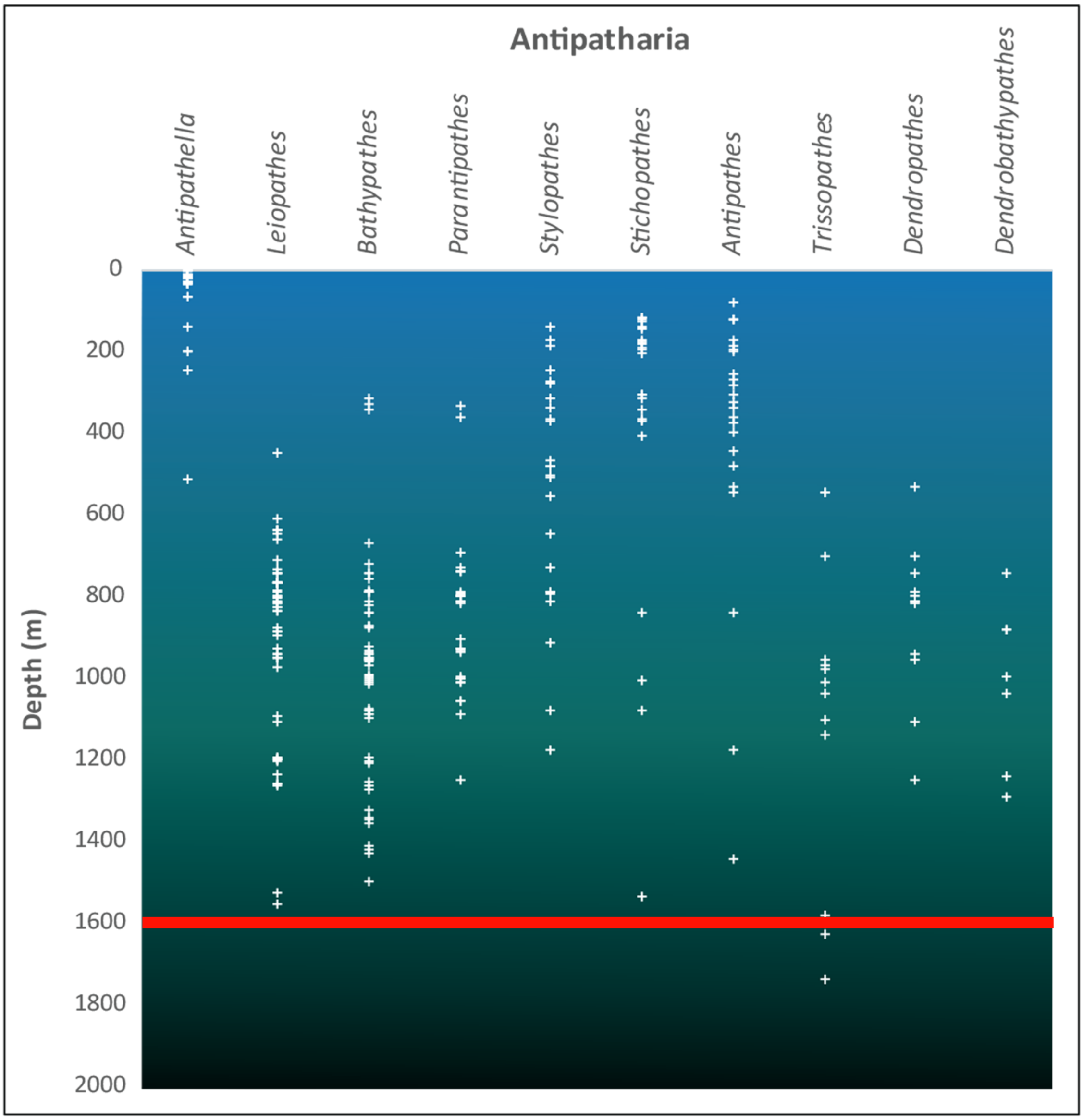


Figure 9: Depth distribution of the ten most abundant black coral genera. Source: Tracey & Hjorvarsdottir, 2019[183]. The red line represents the maximum depth New Zealand deep-sea trawlers operate, 1,600m (generally deep-sea trawlers operate between 200m - 800m)[184].

Gorgonian Octocorals:

There are over 250 known species of gorgonian octocorals (Order Alcyonacea) found within Aotearoa's EEZ, with varying distributions (Figure 10). Some gorgonian octocorals are well represented in the deep-sea and can commonly occur at depths of 1,500m or more while others commonly occur between 200m – 1,200m water depth (Figure 11)[185].

[183] Figure 37
[184] Fisheries New Zealand, 2020
[185] Tracey & Hjorvarsdottir, 2019

Eight species of bubblegum corals are endemic (*Paragorgia spp*) and one octocoral that lives as a single solitary polyp is also endemic (*Taiaroa tauhou*)[186]. This endemic octocoral is found widespread on soft sediment on the Chatham Rise. Plexaura is a cosmopolitan family of gorgonian octocorals and is poorly described in Aotearoa but known to occur from nearshore to the deep-sea. It is likely that Aotearoa has endemic plexaurid species, but these have yet to be fully identified[187].

A recent genetic study of octocorals highlights the evolutionary knowledge of the group. It found that "*the assemblage of octocoral species contained within bottom trawling bycatch are genetically distinct from each other in the contemporary sense, but the evolutionary processes that generated this current breadth of diversity span a period of at least 140 million years*"[188]. This supports that Aotearoa is home to a vast number of genetically unique protected corals.

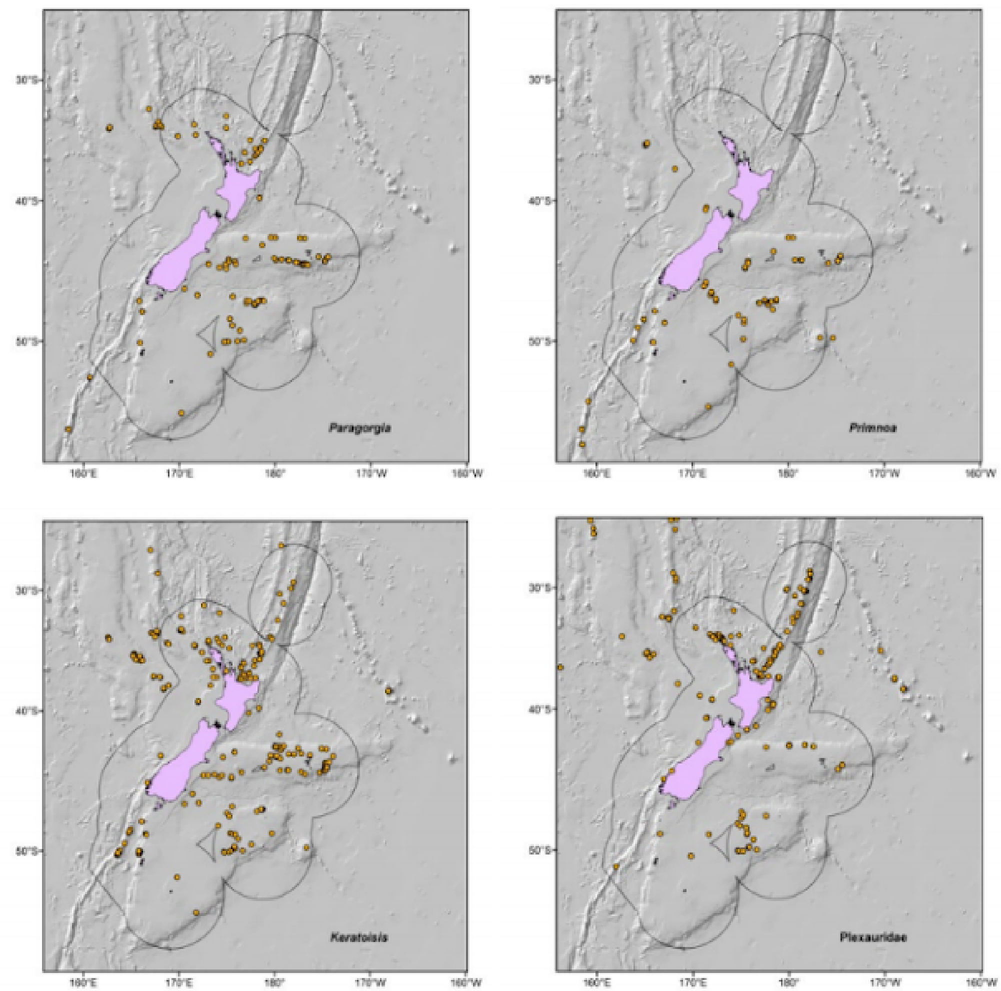


Figure 10: Distribution maps for key gorgonian octocorals located in Aotearoa. Top L to R: Bubblegum coral Paragorgia and sea fan Primnoa. Bottom L to R: Bamboo coral Keratoisis and Family Plexauridae. Published as supplementary material in Anderson et al. (2016). Source: Tracey & Hjorvarsdottir, 2019[189]

[186] Tracey & Hjorvarsdottir, 2019
[187] Tracey & Hjorvarsdottir, 2019
[188] Park et al. 201 as described in Bilewitch & Tracey, 2020a
[189] Figure 44

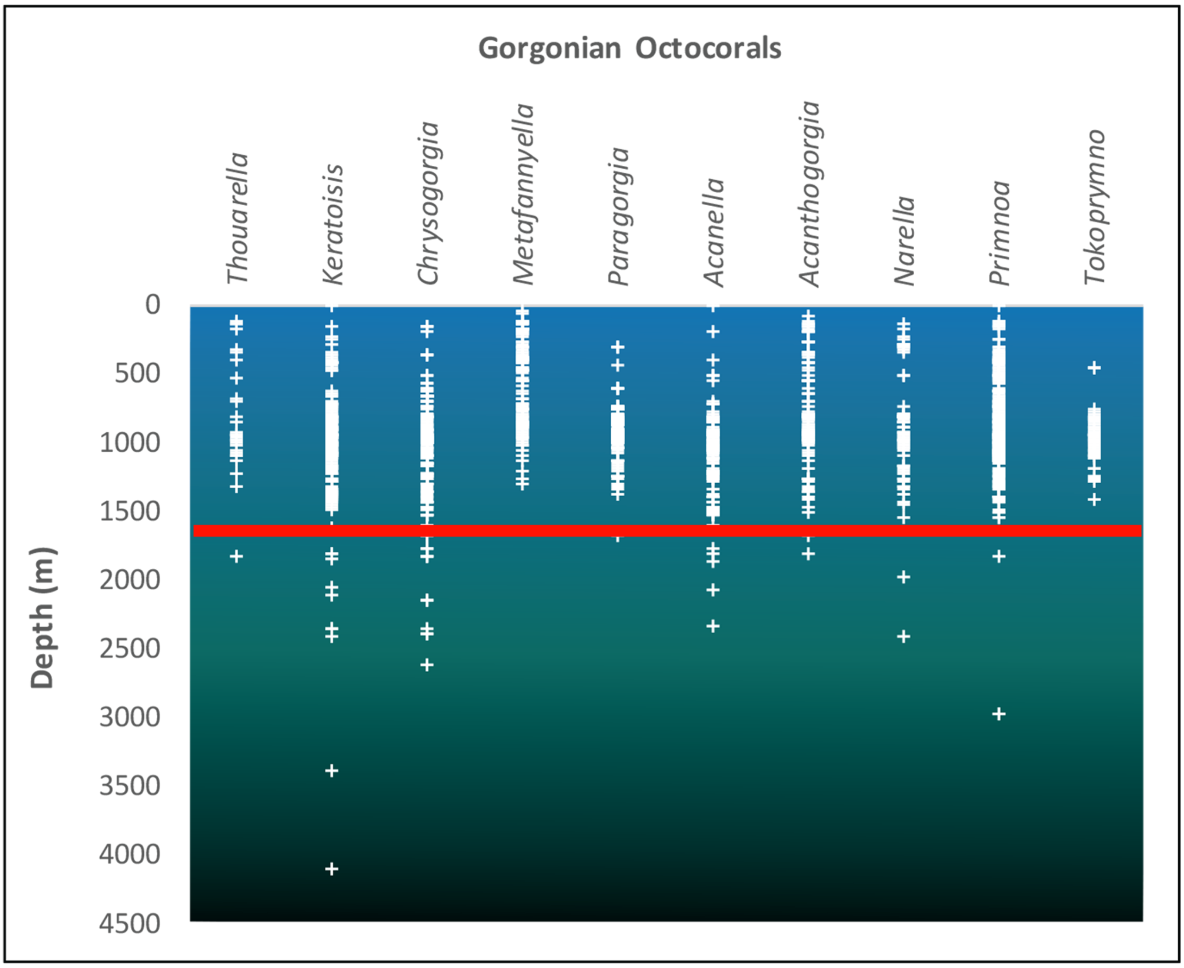


Figure 11: Depth distribution of commonly occurring gorgonian octocorals. Source: Tracey & Hjorvarsdottir, 2019 [190]. The red line represents the maximum depth New Zealand deep-sea trawlers operate, 1,600m (generally deep-sea trawlers operate between 200m - 800m)[191].

Hydrocorals:

Several species of hydrocorals (Family Stylasteridae) are found throughout Aotearoa's EEZ (Figure 12), one of which is known to be endemic (*Errina novaezelandiae*). Stylasterid hydrocorals have a large depth range[192], but most genera commonly occur within 200m – 1,000m depth (figure 13).

[190] Figure 41
[191] Fisheries New Zealand, 2020
[192] Tracey & Hjorvarsdottir, 2019

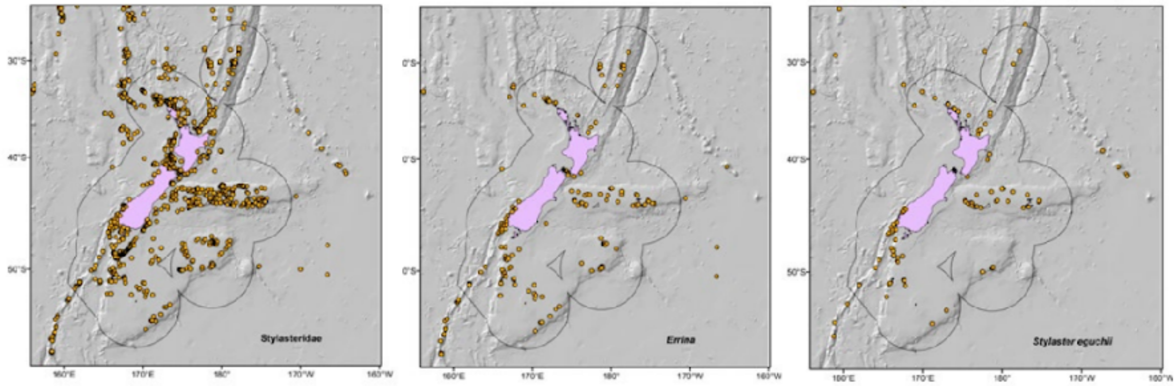
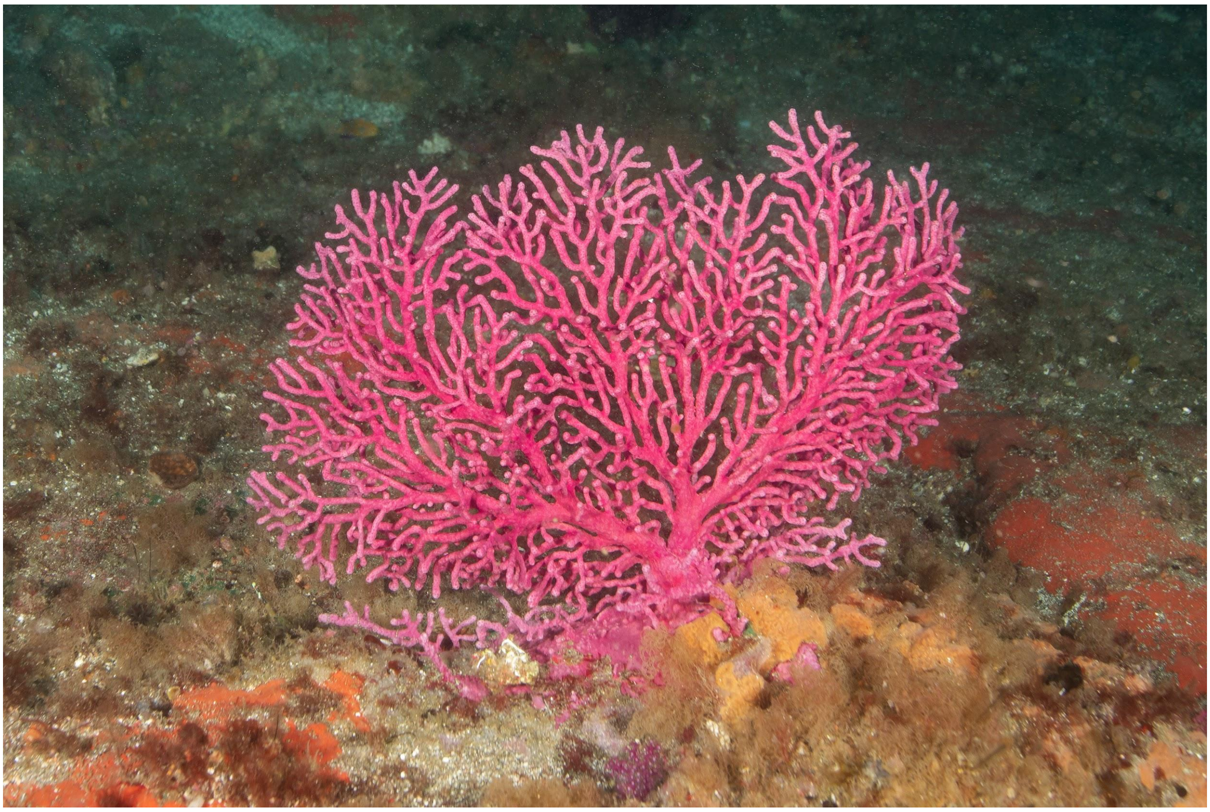


Figure 12: Distribution map of all Stylasteridae hydrocorals (left), and most common species *Errina novaezelandiae* (middle), and *Stylaster eguchii* (right). Published as supplementary material in Anderson et al. (2016). Tracey & Hjorvarsdottir, 2019[193]



© Paul Caiger. Hydrocoral, Kermadec Islands, New Zealand 2020

[193] Figure 46

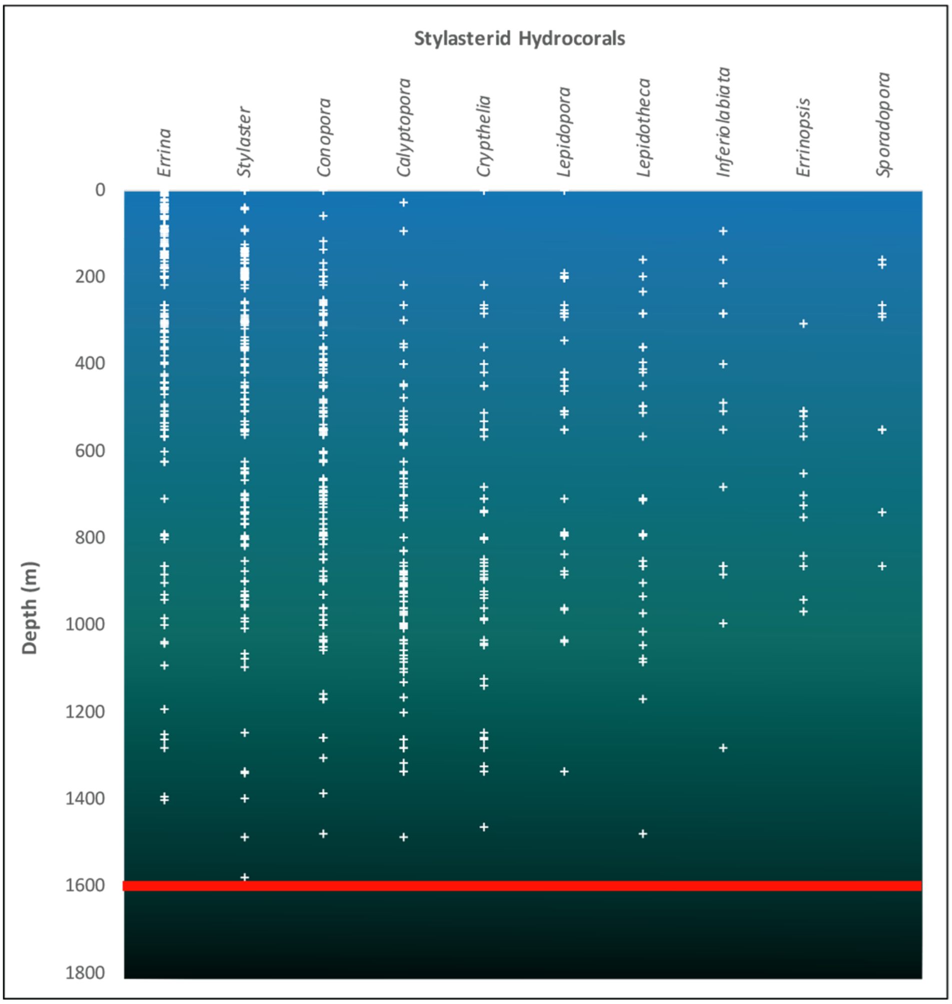


Figure 13: Depth range plot for the ten most abundant stylasterid hydrocoral genera. Source: Tracey & Hjorvarsdottir, 2019[194]. The red line represents the maximum depth New Zealand deep-sea trawlers operate, 1,600m (generally deep-sea trawlers operate between 200m - 800m)[195].

Unprotected Coral and Non-coral Invertebrate Diversity and Distribution

True soft corals, zoantharians and sea pens are not protected in Aotearoa under the Wildlife Act 1953, despite some species being described as ecologically important benthic communities found from shallow waters down to the deep-sea[196].

True soft corals

There is a lack of knowledge on the distribution and ecology of soft corals. Scientists estimate there are at least four endemic species of shallow-water soft corals[197]. Some species of non-gorgonian octocorals are found in relatively shallow waters and others can live very deep

[194] Figure 47
[195] Fisheries New Zealand, 2020
[196] Tracey & Hjorvarsdottir, 2019
[197] Tracey & Hjorvarsdottir, 2019

beyond 1,300m depth (Figure 14)[198]. A large majority of common non-gorgonian octocorals are found between 500m – 1,200m depth (Figure 14).

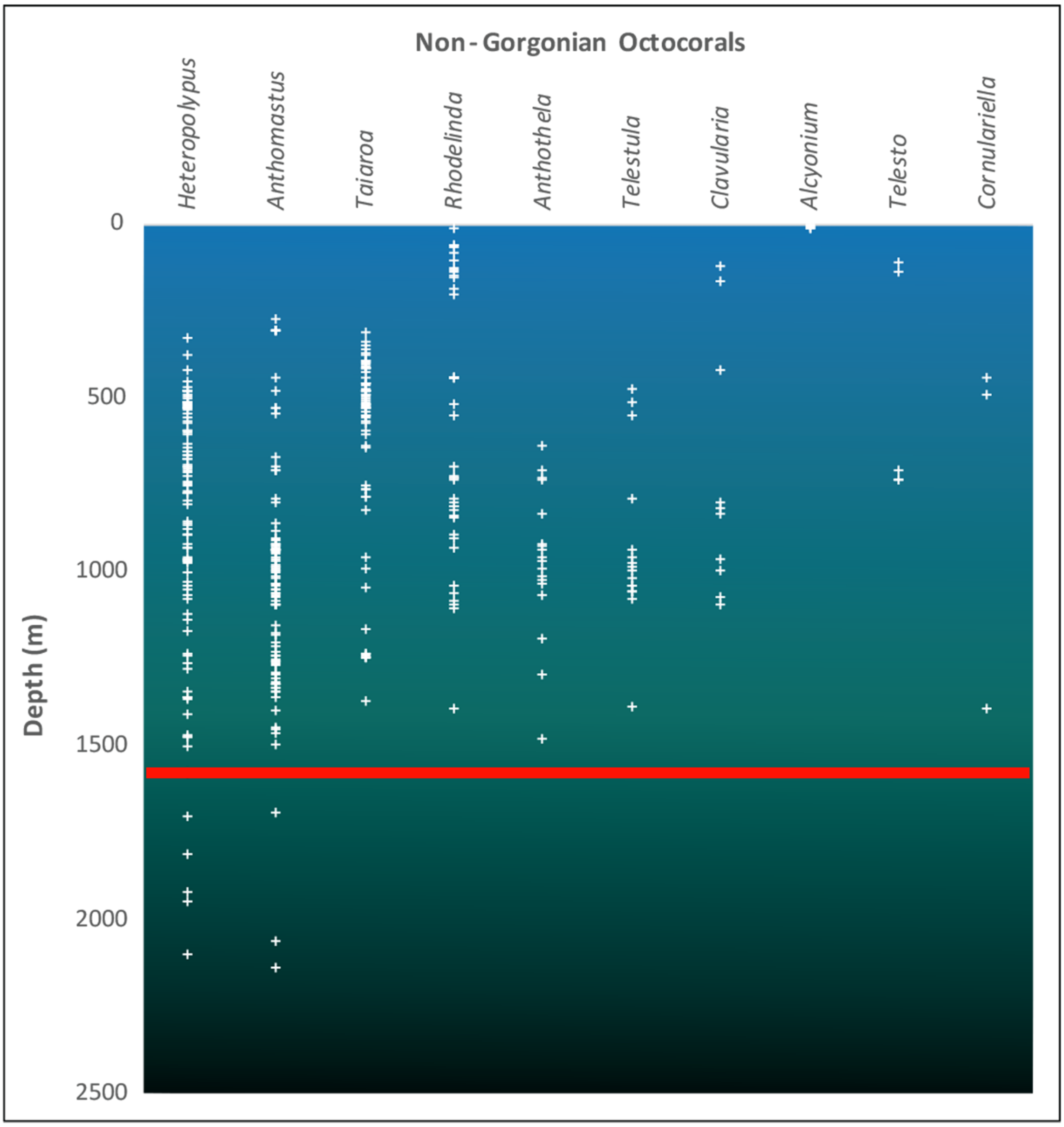


Figure 14: Depth distribution of the most commonly occurring soft corals. Source: Tracey & Hjorvarsdottir, 2019[199]. The red line represents the maximum depth New Zealand deep-sea trawlers operate, 1,600m (generally deep-sea trawlers operate between 200m - 800m)[200].

198 Tracey & Hjorvarsdottir, 2019
199 Figure 49
200 Fisheries New Zealand, 2020

Sea pens

Sea pens belong to the order Pennatulacea and are classified as VME indicator species[201]. Sea pens are widely distributed (Figure 15) and are an important soft-sediment stabilizer species that also provides important three-dimensional habitat for fish and other invertebrates[202].

Scientists have identified 31 species of sea pens from Aotearoa which equates to about 15% of the global fauna[203]. Some are found in shallower waters, usually greater than 50m, while others live in deeper waters down to the abyssal plain. There is no data available from Aotearoa to determine if any species found here are endemic.

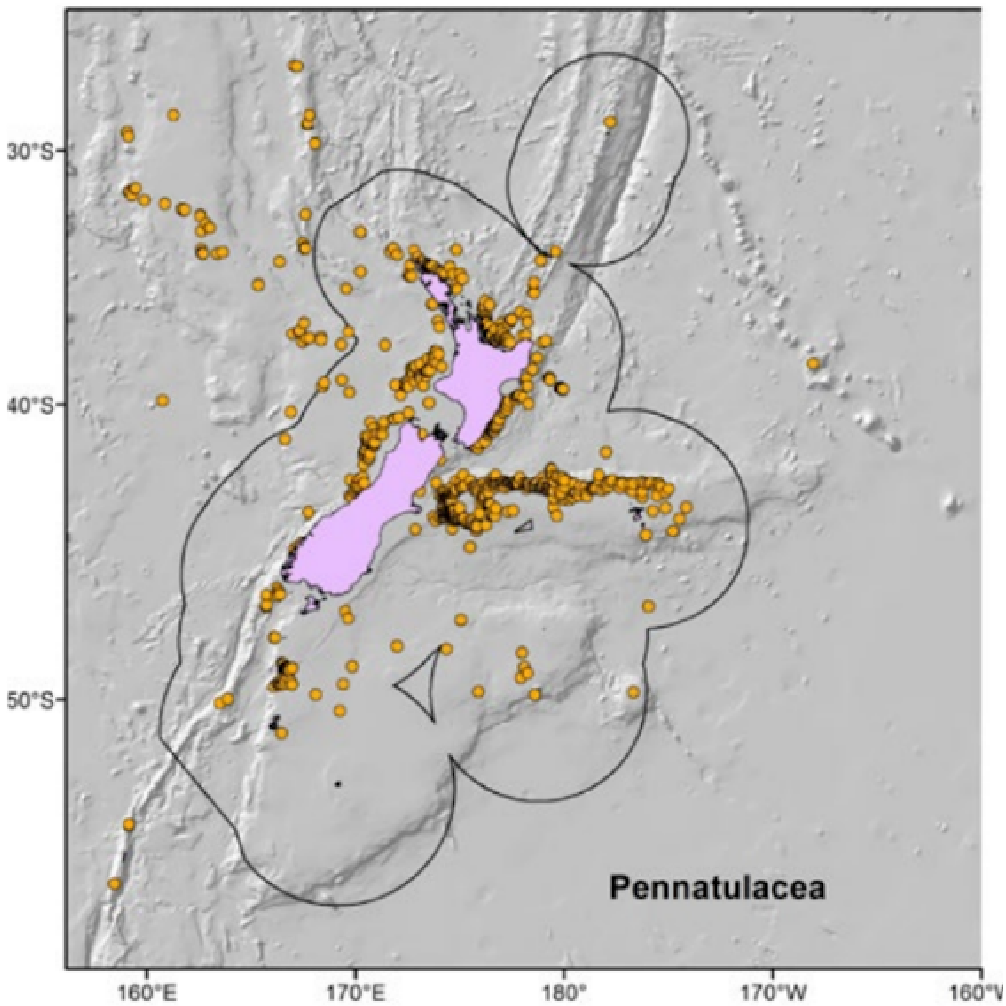


Figure 15: Distribution map of all sea pens (Order Pennatulacea) (Published as supplementary material in Anderson et al. (2016). Source: Tracey & Hjorvarsdottir, 2019[204]

[201] Tracey & Hjorvarsdottir, 2019
[202] Baillon et al, 2012 described in Tracey & Hjorvarsdottir, 2019
[203] Tracey & Thorvaldsdottir, 2019
[204] Figure 52

Zoantharia

Scientists have discovered two species of a unique 'gold coral' which is actually rare zoantharians. These gold corals are unprotected in Aotearoa waters as they are not listed on Schedule 7A under the Wildlife Act 1953. One species (*Savali sp*) is found between 10 - 300m, whilst the other (*Kulamamanamana haumeaae*) is found in deeper waters[205].

Coral core depth distributions

Deep water is classified as 200m and beyond.

In summary, stony corals are predominantly found between 800m - 1,200m deep, black corals are generally found between 200 - 1000m, gorgonian octocorals and hydrocorals generally have a wide depth distribution and can be found down to 1,500m or deeper, while most soft corals (non-gorgonian) also have a broad range from shallow to deeper waters with a max depth of around 1,300m[206]. Based on the depth distribution plots (Figures 5, 9, 11, 15 and 14) from Tracey & Hjorvarsdottir (2019), and what is known about the depths different corals live, it can be generalised that most Aotearoa deep-sea coral taxa can be found between 200 - 1,000m, we refer to this as the 'core depth distribution' in this report.

© Paul Caiger. Gorgonian Fan (Alcyonacea), Kermadec Islands, New Zealand 2020

Non-coral deep-sea invertebrates diversity

Aotearoa has a diverse range of non-coral deep-sea invertebrates that live on or around seamounts and are often caught as bycatch by deep-sea bottom trawl vessels, these include sponges, sea-stars, starfish, sea-lilies, barnacles, limpets, squid, crabs, prawns, sand dollars, sea

[205] Tracey & Hjorvarsdottir, 2019
[206] Tracey & Hjorvarsdottir, 2019

urchins and deep-sea fish species[207]. It is highly likely some of these non-coral deep-sea invertebrates found within Aotearoa's EEZ are endemic, but there is a lack of published literature on this.

Over the past three years, scientists in Aotearoa have identified 135 taxa new to science from fisheries bycatch samples collected between 1994 to 2020 (Figure 16 and 17), including 128 new species, 6 new genera and one new family, as part of an invertebrate identification project[208].

Most of the samples containing new taxa were collected on research trawl surveys (219 of 318). Samples collected by observers on commercial fishing vessels, which contained new taxa, and are currently able to be attributed to a fishery, are shown in Table 3[209].

This research shows that some of the very areas that scientists are discovering new species from are also the same areas being bottom trawled. This means there is the potential for New Zealand vessels to destroy endemic or rare invertebrate species before they can be discovered and identified. This highlights the importance of taking a precautionary approach and protecting these important deep-sea ecosystems and associated biodiversity, like those around seamounts.

Table 3: The number of new invertebrate taxa identified in Schnabel et al. (2021) broken down by target fishery samples were collected in, Source: Unpublished data from FNZ, 2021.

Target fishery species	**Total number of samples containing new taxa**
Barracouta	7
Bass groper	6
Hoki	8
Hapuka/Bass	3
Jack mackerel	1
Ling	1
Orange roughy	13
School shark	4
Scampi	5
Snapper	1
Squid	20
Oreos (SSO)	3
Tarakihi	1
Grand Total	**73**

[207] Ministry of Fisheries, 2011
[208] Schnabel et al 2021
[209] Unpublished data from Fisheries New Zealand, 2021

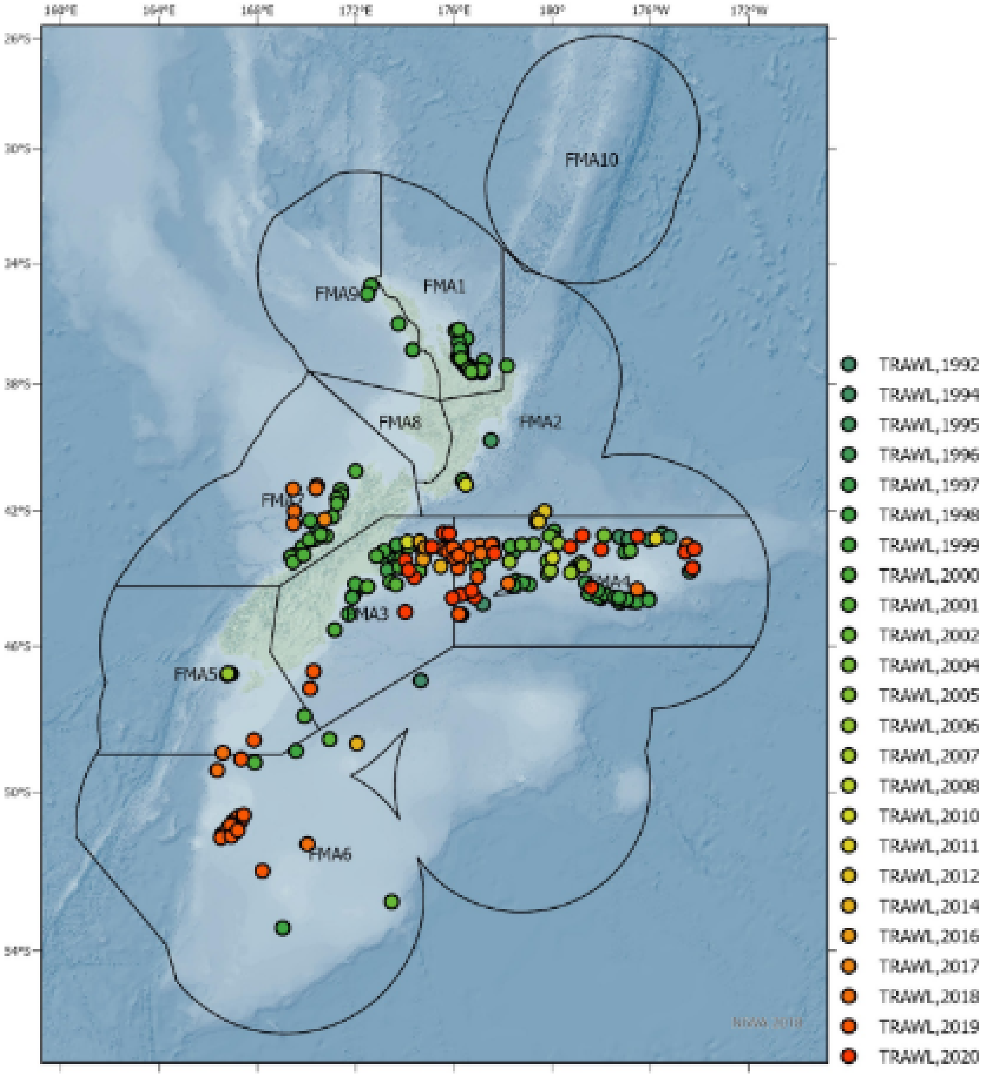


Figure 16: A plot of the location of invertebrate samples processed in Schnable et al (2021) collected from research trawl surveys. Coloured dots represent collection year with the oldest samples in dark green, and the most recent in dark red. Source: Schnabel et al (2021)

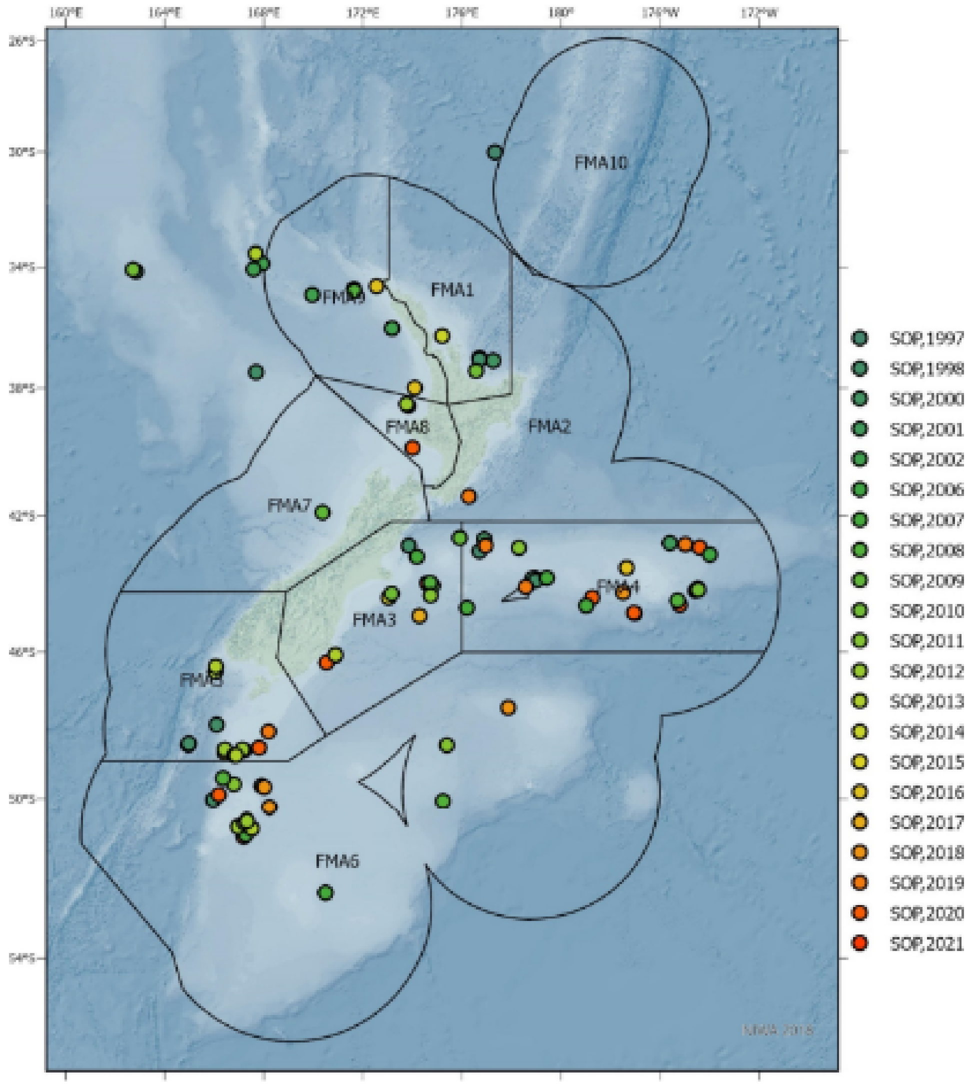


Figure 17: A plot of the location of invertebrate samples processed in Schnable et al (2021) collected from observers on commercial vessels. Coloured dots represent collection year with the oldest samples in dark green, and the most recent in dark red. Source: Schnabel et al (2021)

More research is needed to describe deep-sea soft sediment fauna. Researchers have looked at the effects of trawling on benthic mega-epifaunal and macro-infaunal communities on the Chatham Rise and found that bottom trawling can significantly modify the structure and functional composition of epifaunal communities in deep-sea soft sediment environments, by reducing the density of taxa and diversity[210]. This modification of deep-sea soft sediment such as the loss of epifaunal diversity is concerning as this could result in a loss of ecosystem function such as reduction in the availability of species for benthic-feeding demersal fish[211].

[210] Bowden & Luduc, 2017
[211] Bowden & Luduc, 2017

Section 3: Overview of seamount biodiversity in the South Pacific

The Pacific Ocean has the highest number of seamounts of all the world's oceans[212] (Figure 18).

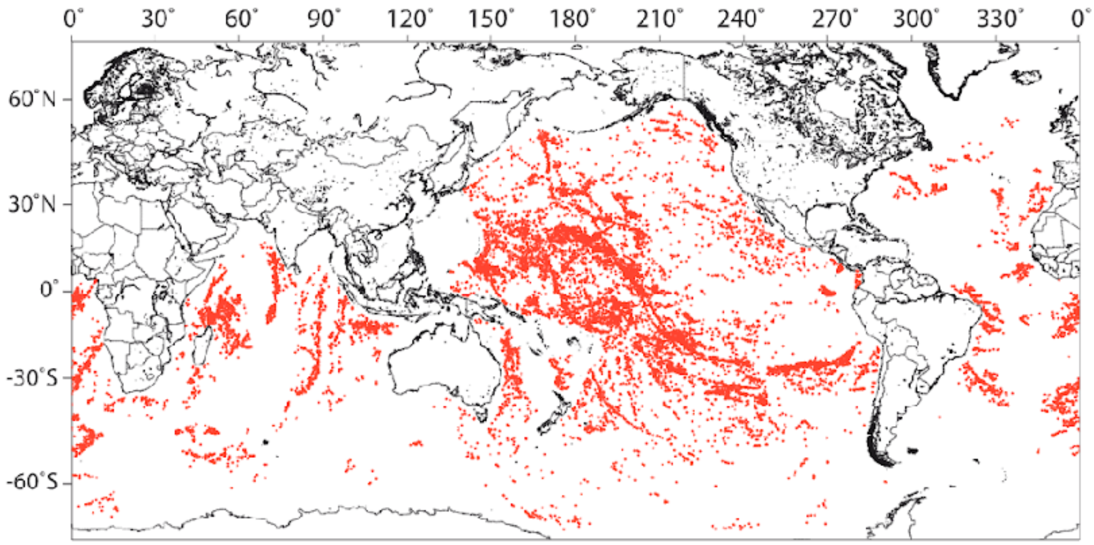


Figure 18: Global distribution of 118,882 seamounts described by Wessel *et al.*, (2010) from Lyer *et al.* (2013).

The high seas, the area of ocean beyond national jurisdiction, comprises two-thirds of the global ocean and covers nearly half the planet. These areas beyond national jurisdiction are divided up into regional fisheries management areas. The South Pacific Regional Fisheries Management Organisation (SPRFMO) area (Figure 19) extends all around Aotearoa's EEZ.

The United Nations General Assembly (UNGA) has set out resolutions[213] to globally minimise the effects of seafloor fisheries on the high seas. To meet these resolutions, in some oceans around the world little or no bottom trawling occurs on seamounts in the high seas. For example, in September 2021, at the 43rd annual meeting of the Northwest Atlantic Fisheries Organisation (NAFO) NAFO agreed to fully protect all seamounts and other features less than 4,000m depth from bottom trawling[214]. NAFO seamount closures cover an area approximately 100,000 square kilometres[215], that's almost the same size at the whole of the North Island[216].

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[212] Kitchingman et al. 2008

[213] UNGA Resolution 61/05: The UN General Assembly, in Resolution 61/105, adopted in 2006, called on "*States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain*" (Paragraph 80)

[214] NAFO, 2021. Press release: NAFO agrees to further measures to protect Vulnerable Marine Ecosystems (VMEs) at its 42rd Annual Meeting pressrelease_AM2021.pdf (nafo.int). Retrieved 26 September 2021

[215] DSCC, 2021. Press release 24/9/21: New Protections for Fragile Deep-sea Ecosystems Agreed by Northwest Atlantic Fisheries Organisation. New protections for fragile deep-sea ecosystems agreed by Northwest Atlantic Fisheries Organisation - Deep Sea Conservation Coalition (savethehighseas.org). Retrieved 26 September 2021

[216] North Island Area 113,729km^2 – Source: New Zealand Official Yearbook, 2000 from Statistics New Zealand Quick Facts - Land and Environment : Geography - Physical Features (archive.org). Retrieved 26 September 2021

In the South Pacific, largely due to the New Zealand Government's influence at the SPRFMO the vulnerable deep-sea communities and ecosystems on seamounts and similar features are still at risk from benthic disturbance, as a fleet of New Zealand owned trawlers are actively bottom trawling (Figure 19).

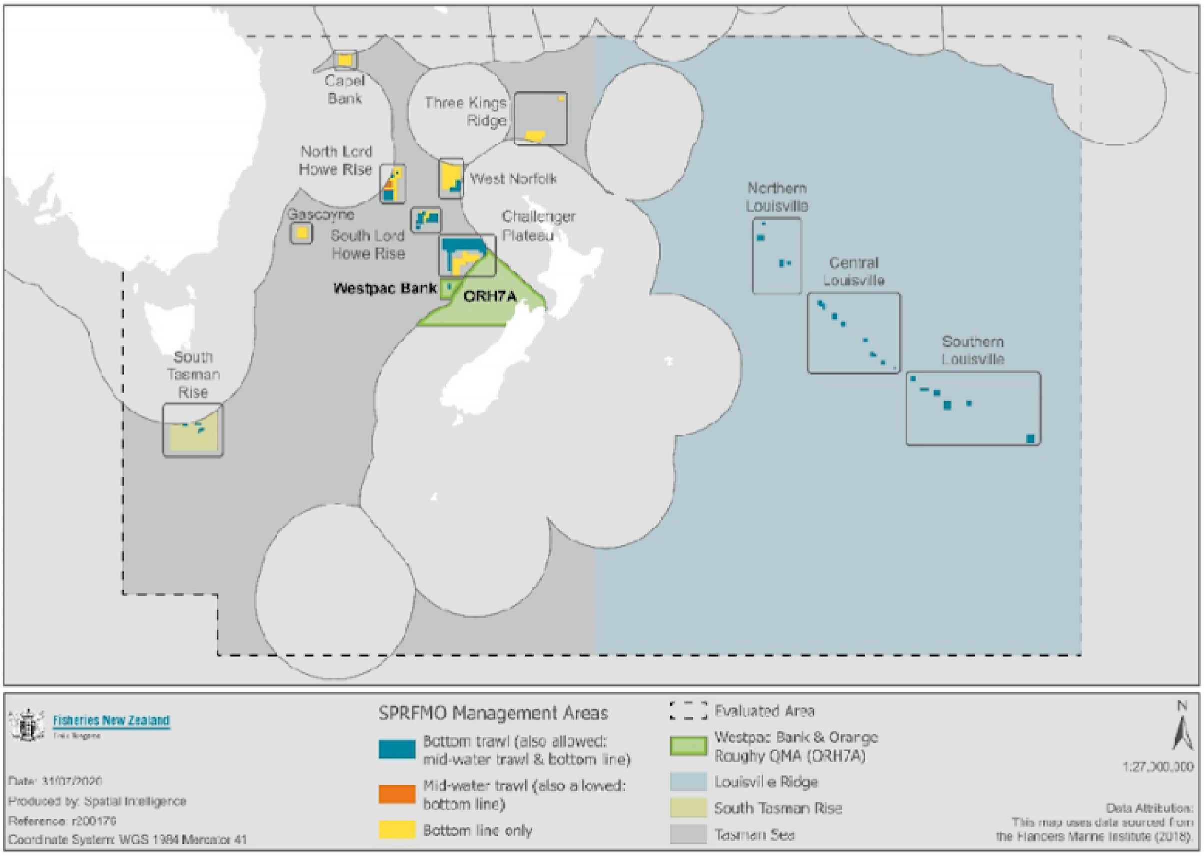

Figure 19: SPRFMO management area showing areas New Zealand bottom trawlers operate since 2006 overlaid with the CMM03-2019 management. Source: Fisheries New Zealand, 2021

South Pacific Regional Fisheries Management Organisation:

Within the SPRFMO area New Zealand is the only country currently bottom trawling on seamounts primarily targeting orange roughy[217] and alfonsino. As of 1 July 2021, Fisheries New Zealand authorised six New Zealand owned bottom trawl vessels to fish in this predominantly seamount-focused fishery[218]. Figure 20 shows the SPRFMO regulatory area (blue) and known seamounts (red dots). Figure 21 shows SPRFMO regulatory area (purple line) and known 'fishable'[219] seamounts (yellow dots)[220].

[217] Orange roughy is the main target species and has made up 67-99% of the total New Zealand bottom trawl catch since 2002 with tonnages ranging from 301 to 2 578 tonnes: Source Fisheries New Zealand, 2021

[218] All six vessels belong to companies or skippers that have been convicted in the past year of trawling illegally in closed areas

[219] 'fishable' means the seamount is within the fishable depth of 0 - 1,500m

[220] Fuller et al. 2020

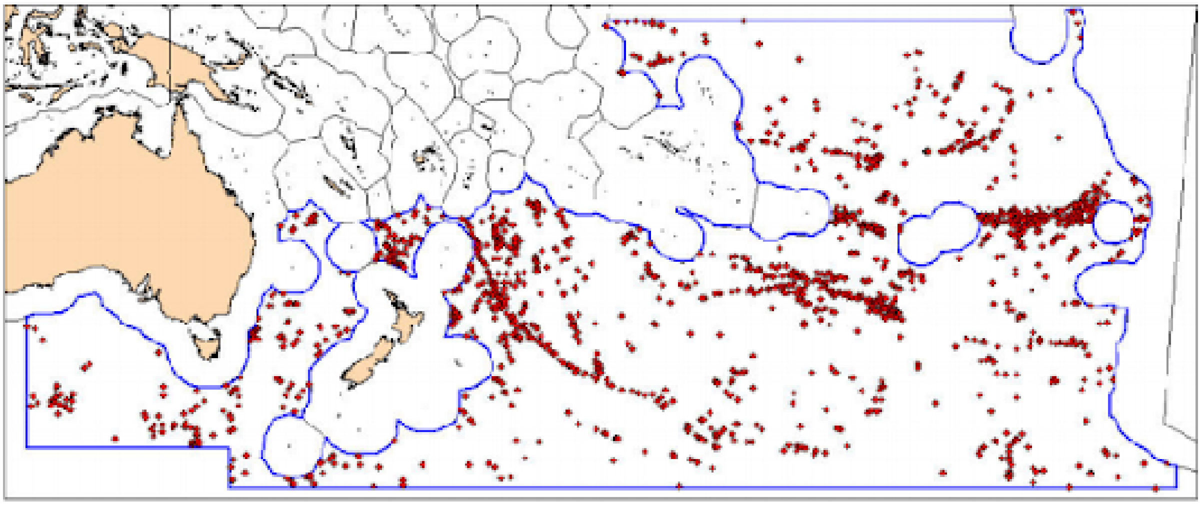

Figure 20: Geographic distribution of validated seamounts and similar under-water features within the SPRFMO regulatory area. Source: Allain & Clark, 2008

© CSIRO, 2018. A high diversity of stony corals and sponges. From seamount biodiversity study in the South West Pacific, on Tasmanian seamounts.

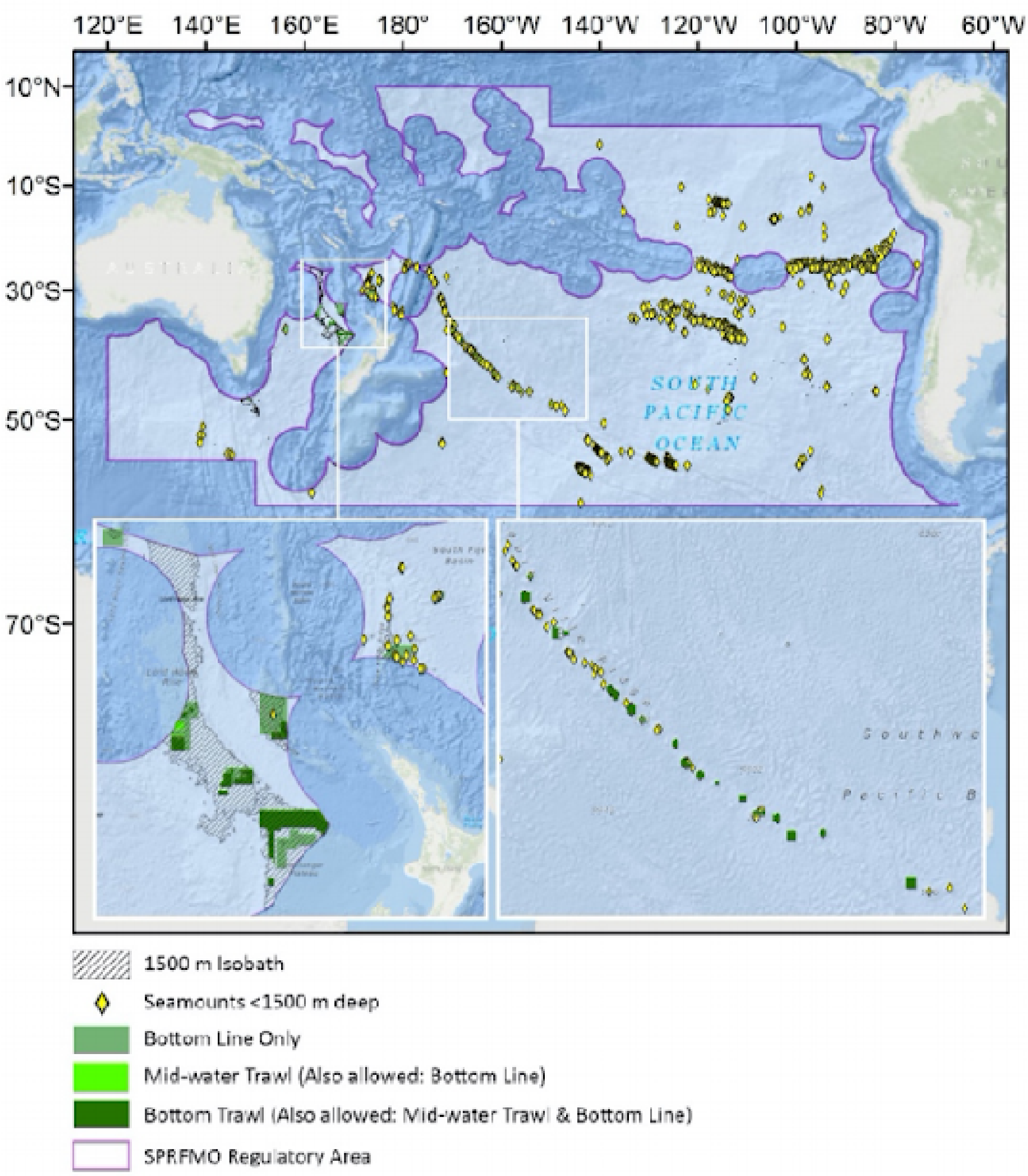

Figure 21: Map of the SPRFMO regulatory area showing seamounts within 'fishable' depth (<1,500m). Source: Fuller et al., 2020.

South Pacific Seamounts Biodiversity

Identifying the locations of seamounts within SPRFMO is important. Watling and Auster (2017) reviewed seamount locations and the presence of VME indicator species from within the SPRFMO area and found that "*all seamounts that have so far been surveyed by cameras, either towed or mounted on maneuverable submersible vehicles, have been found to have abundant VME indicator species* *(including xenophyophores on sandy areas) distributed on their sides and summits*"[221]. Watling and Auster (2017) also conclude "*the distribution of VME indicator species is far more extensive than fishery bycatch data would suggest. The lack of VME species in virtually all trawl catches on seamounts is due entirely to their fragility and brittleness. While some large pieces of VME species encountered might be retained in the coarse meshes of a commercial trawl net or snagged on fixed gears such as longlines, the biomass would rarely be high enough to trigger an official "encounter" as most are surely broken into small pieces and fall to the seafloor before reaching the deck of the ship'*[222]. This reinforces the assumption that all seamounts, even acknowledging that distributions across seamounts can vary, that occur within the biological depth ranges of VME indicator species, like deep-sea corals, should be considered to contain VMEs and therefore warrant full protection in order to meet international obligations such as UNGA resolutions[223]

SPRFMO has some controls in place which New Zealand trawlers must follow (refer to Figure 19 & Figure 21) to reduce the impact on VMEs from bottom trawling including 100% observer coverage, move-on rules[224], and requiring pre-trawling impact assessments. New Zealand has argued for 'spatial management', which by that mean that SPRFMO allows the destruction of VMEs on the basis that there are other VMEs found elsewhere)[225]. These measures are not adequate as they do not comply with the UNGA resolutions to fully prevent all significant adverse impacts (SAI) on VMEs.

There has been no comprehensive assessment of the deep-sea benthic biodiversity found within SPRFMO and specifically associated with SPRFMO 'fishable' seamounts besides limited research, observer bycatch data and predictive habitat suitability modelling. This means it is impossible to determine the level of endemism and presence of rare or unique species. What is known is that the bycatch of corals and other vulnerable deep-sea species by New Zealand bottom trawl vessels on seamounts in the South Pacific is often high.

New Zealand vessels reported benthic bycatch exceeding 1,000 kg per tow in places like the Three Kings Ridge and Wanganella Bank of bushy hard corals[226]. One vessel was reported to have taken 5,000 kg of coral in a single tow while bottom trawling on the Louisville Ridge Seamount Chain[227]. As described earlier the bycatch that ends up at the surface observed is not the total destroyed, much more is destroyed on the seabed[228]. This means in some of the highest bycatch incidents by New Zealand trawlers in the South Pacific, these incidents may have actually destroyed between 122 and 1,700 tonnes of deep-sea corals and other vulnerable benthic species from single trawls[229].

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[221] Watling and Auster, 2017

[222] Watling and Auster, 2017

[223] e.g.61/50 in 2006 called "*upon States to take action immediately, individually, and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems [VMEs], including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance, and value of deep-sea ecosystems and the biodiversity they contain*."

[224] Move-on rules require a vessel to move one nautical mile away from where it is trawling if a certain amount of vulnerable indicator species are observed. VME indicator taxa include stony corals, soft corals, black corals

[225] DSCC, 2020

[226] Cryer & Geange, 2018

[227] Maximum bycatch from Cryer and Geange, 2018 and Cryer et al. 2018.

[228] Pitcher et al. 2019

[229] A trawl bringing up 1.133 mt of bycatch (Three Kings Ridge and Wanganella Bank) indicates 122 - 385 mt destroyed on the seabed, while 5.001 mt bycatch trawled up from Louisville Ridge indicates 540 - 1,700 mt destroyed on the seabed. Sources: Cryer and Geange, 2018 (bycatch) and Pitcher et al. 2019 (destruction on the seabed)

New Zealand owned bottom trawlers fishing for orange roughy in the South Tasman Rise have reportedly caught a large diversity of coral species, often dominated by reef-forming stony corals such as *Solensmilia variabilis*[230].

One study looked at fish and macroinvertebrates diversity from seamounts in the Tasman and Coral Seas in the Southwest Pacific (taxa samples were taken from seamounts within and outside of SPRFMO), Figure 22[231]. Of the 516 taxa samples taken from 6 seamounts along the Norfolk Ridge, 36% of invertebrates were species new to science and were not found in the surrounding areas indicating high levels of endemism[232]. Of the 108 taxa samples taken from 4 seamounts on the Lord Howe Rise, 31% were new to science and of the 297 taxa samples taken from 14 seamounts south of Tasmania (within Australia's EEZ) between 16 - 33% were species new to science[233].

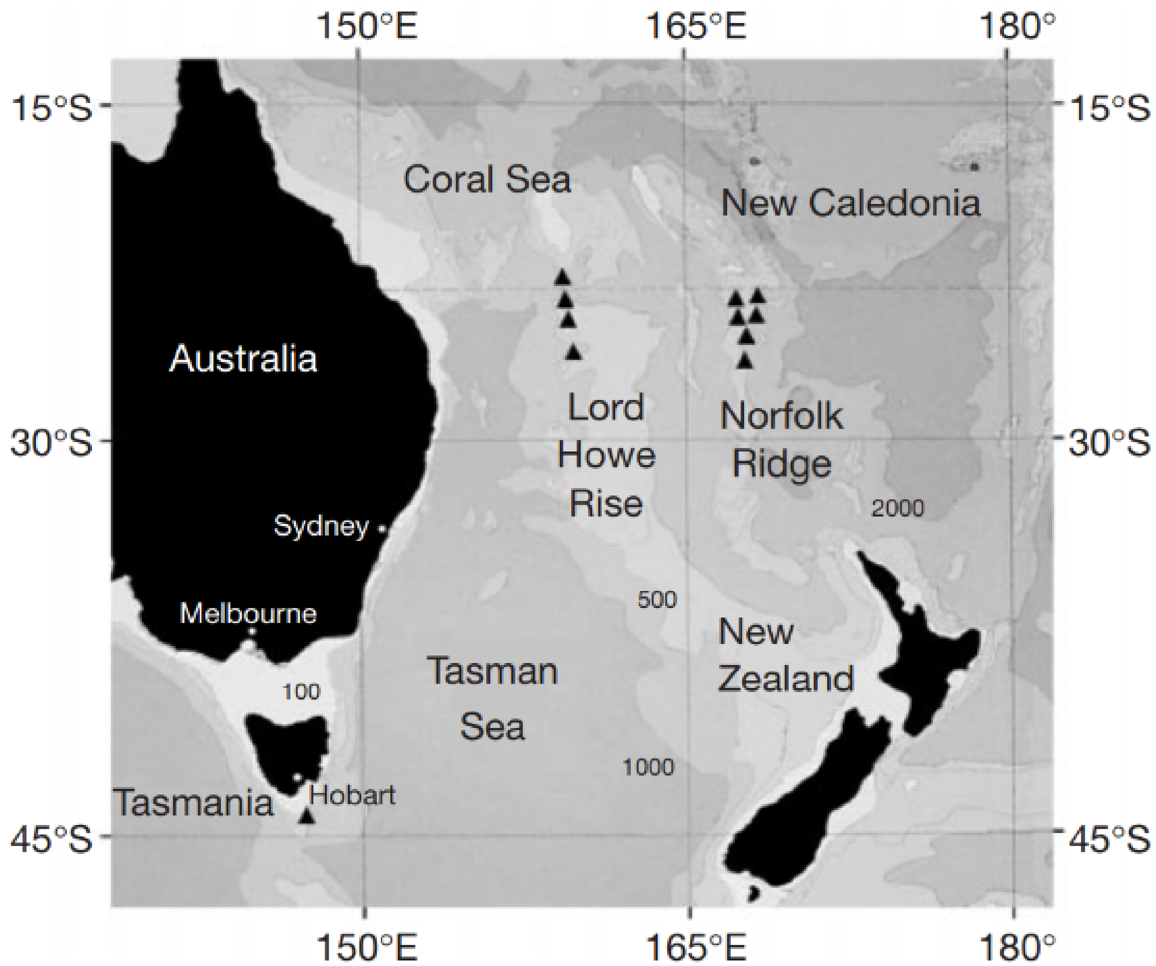


Figure 22: Location of seamount sampling sites (triangles) from Richer de Forges *et a*l. (2000)

VME bycatch by New Zealand fishers is not a historic issue. New Zealand is still reporting high bycatch rates of VME indicator species to SPRFMO. In 2020, a New Zealand vessel exceeded

[230] Anderson & Clark, 2003
[231] Richer de Forges et al 2000
[232] Richer de Forges et al 2000
[233] Richer de Forges et al 2000

the amount of VME indicator species that can be trawled up in a single trawl within the North Lord Howe region[234]. It's reported the incident took place on the Lord Howe Rise plateau area (Figure 23) and that between 18 - 20kgs[235] of Alcyonacea Gorgonian coral was brought up[236]. New Zealand has not provided the 2021 meeting of the Scientific Committee[237] with any further details around the encounter, such as vessel details[238], if the bycatch was identified to a lower taxonomic level[239] and whether or not the bycatch represented multiple species, or if a sample of the bycatch was brought back to New Zealand for any further identification[240]. New Zealand is recommending to reopen the area to bottom trawling and states based on their assessment that "*bottom trawling is unlikely to cause SAI* [significant adverse impacts] *to VMEs at the FMA* [fisheries management area] *scale. While it cannot be completely excluded that reopening the area to trawling could result in encounters with other VMEs at the sub-tow spatial scale, this risk is considered to be low*"[241].

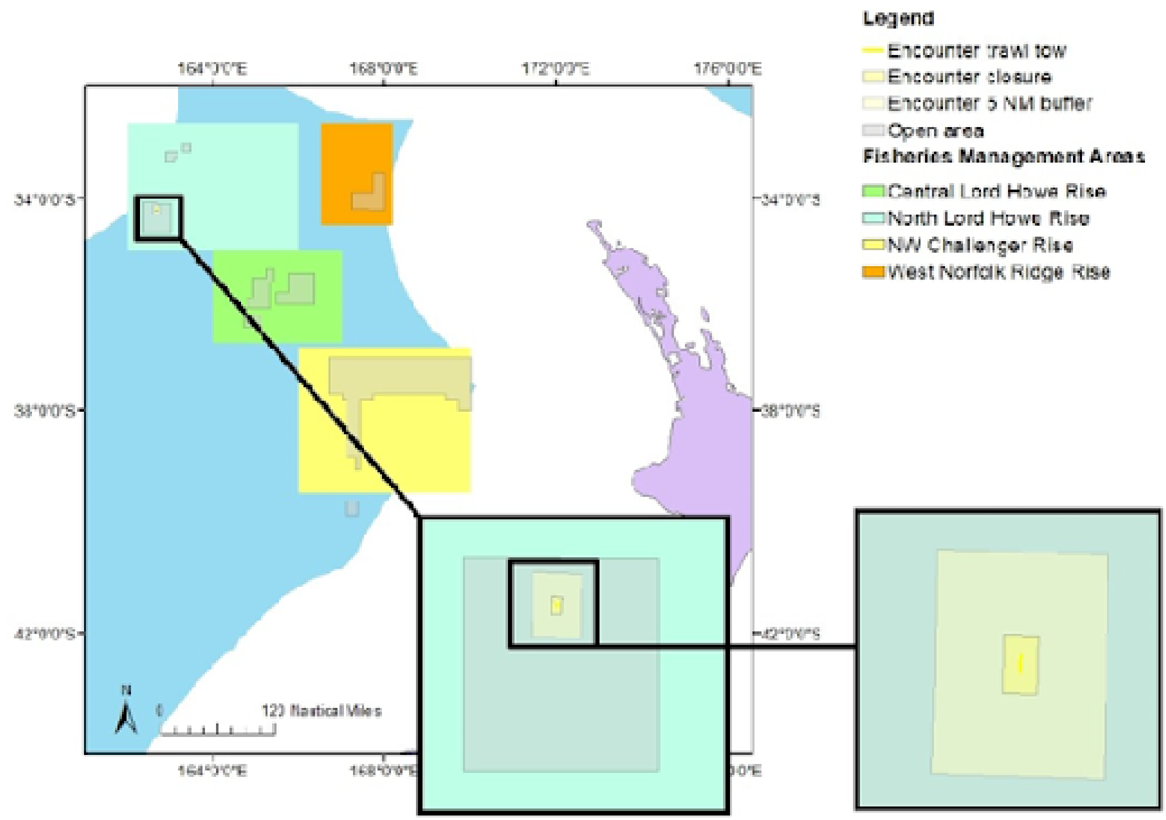


Figure 23: Location of the 2020 VME encounter by New Zealand bottom trawler within the North Lord Howe Rise FMA (teal polygon). Source: Milardi et al. 2021

Like in Aotearoa, there is a critical information gap which is that most New Zealand fisheries observers can't accurately identify benthic species, as they simply are not taxonomic experts. This

[234] Milardi et al. 2021
[235] Threshold weight is 15kgs
[236] Milardi et al. 2021
[237] The 9th meeting of the SPRFMO Scientific Committee held virtually 27th September to 2nd October, 2021
[238] New Zealand states there is an ongoing compliance investigation, see Milardi et al. 2021
[239] Most bycatch is reported at the taxonomic level of Order or higher
[240] Greenpeace has requested further information from FNZ around the details of the SPRFMO VME encounter, but so far all requests have been denied.
[241] Milardi et al. 2021b – note this reference is now referring to the updated 'SCDW09_rev1' New Zealand 2020 VME encounter review paper

means often benthic-bycatch taxa is identified at the Order (or higher) taxonomic level rather than species level. The consequence of this is that we do not know what levels of endemism or cryptic benthic diversity is being caught as bycatch by New Zealand trawlers.

Based on the benthic bycatch from New Zealand bottom trawlers operating within the SPRFMO area that could be identified, it is estimated that New Zealand vessels have destroyed samples of at least 281 genera and 231 species of VME taxa[242]. The last five years of observed benthic bycatch is shown in Table 4.

The bycatch from New Zealand vessels that has been identified is comparable to the list of known VME taxa[243] identified from a study area within SPRFMO. Of the 5,300 taxa records assessed from within the study area, 281 genus and 231 species of VME taxa were identified[244]. These records are from multiple data sets, including research trawls and fisheries bycatch. Of this, 173 genera and 182 species of VME taxa were identified from fishable depths (<1,400m)[245]. Importantly, this highlights that most of the genera (63%) and species (79%) identified as VME taxa found within the SPRFMO area occur within fishable depths (< 1400m)[246].

This review of VME taxa is likely to be an underestimate of the VME species that live within the entire SPRFMO region because a) only a subset of the region was included in the sample and research has found that seamounts even over short distances can have distinct and unique macroinvertebrate communities (e.g. corals and sponges)[247,248],b) not all of the study samples were able to be identified and c) not all samples had depths recorded. It is important to note that this study is likely to significantly underestimate naturally rare VME species as evidenced by the high percentage (41%) of taxa with only a single observation in the dataset[249]. Additionally, Richer de Forges et al. (2000) found a linear relationship between the number of species recorded from each seamount and the number of samples obtained, which supports that greater sampling effort will result in greater species richness[250].

These reports confirm within the SPRFMO area there are likely hundreds to thousands of VME species, many likely to be rare and endemic, which supports that this area is biologically very important and warrants full protection from benthic disturbance methods, such as bottom trawling in order to comply with the UNGA resolutions to fully prevent all SAI on VMEs.

[242] Fisheries New Zealand, 2021
[243] The review only reported on the 15 VME groups identified in SPRFMO SC7-DW13
[244] Geange et al. 2020
[245] Geange et al. 2020
[246] Geange et al. 2020
[247] Rowden and Clark, 2004
[248] Richer de Forges et al 2000
[249] Geange et al. 2020.
[250] Richer de Forges et al 2000

Table 4: Benthic bycatch reported by observers on New Zealand bottom trawlers within the SPRFMO area between 2016 – 2020. Source)[251] Source: Fisheries New Zealand, 2021

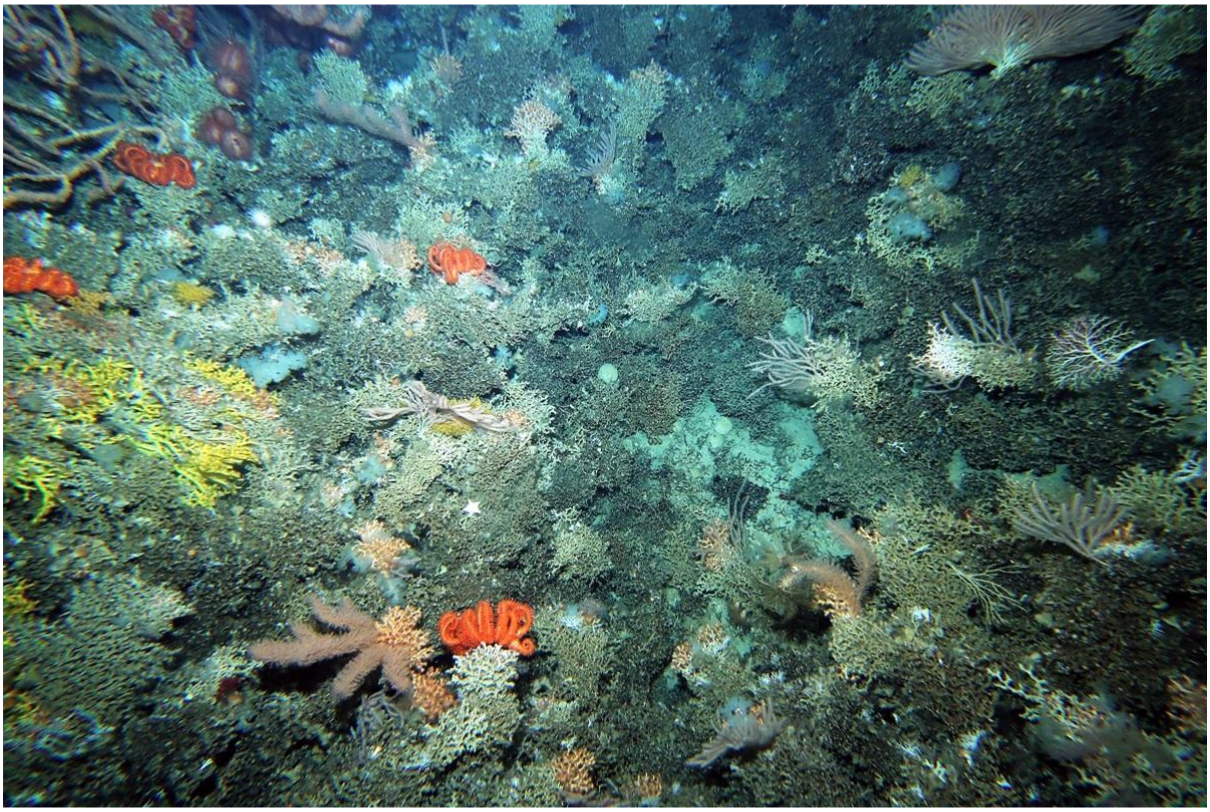
Taxon BOTTOM TRAWL	2016	2017	2018	2019	2020
Arthropoda					
Hexanauplia (Barnacles)	1.7 (4)	0 (0)	0.6 (3)	1.9 (3)	0 (0)
Malacostraca (Crabs, prawns)	6.1 (5)	35.9 (18)	2.9 (4)	8 (3)	3 (2)
Pycnogonida (Sea spiders)	0 (0)	1.0 (1)	0 (0)	1.0 (1)	0 (0)
Brachiopoda (Lamp shells)	0 (0)	1.0 (1)	0 (0)	0 (0)	0 (0)
Bryozoa (Lace corals)	0 (0)	0 (0)	0.4 (2)	0 (0)	0 (0)
Chordata					
Ascidiacea (Sea squirts)	0 (0)	20 (4)	0 (0)	0 (0)	0 (0)
Thaliacea (Tunicates)	4.7 (8)	12.1 (13)	0 (0)	0 (0)	14 (4)
Cnidaria					
Anthozoa (Anemones, corals, sea pens)[1]	546.7 (164)	3369.5 (104)	1252.53 (139)	36.2 (23)	24 (24)
Actiniaria (Anemones)	906.3 (198)	902.5 (159)	989.1 (80)	107.8 (29)	83.5 (34)
Alcyonacea (Soft corals)	0 (0)	0 (0)	0 (0)	0 (0)	0.2 (2)
Antipatharia (Black corals)	48.7 (67)	37.9 (58)	46.9 (69)	13.7 (31)	2.5 (13)
Gorgonian Alcyonacea (Tree-like forms, sea fans, sea whips, bottlebrush)[2]	33.6 (51)	78.9 (73)	45.4 (64)	33.5 (29)	4.3 (7)*
Pennatulacea (Sea pens)	3.3 (15)	18.3 (28)	8.1 (11)	2.1 (10)	1.2 (8)
Scleractinia (Stony corals)[3]	32 (18)	640.1 (61)	47.5 (31)	8.4 (6)	62.8 (40)
Zoantharia (Hexacorals)	194.4 (131)	93.3 (93)	100.9 (57)	1 (1)	9.9 (7)
Hydrozoa (Hydroids)[4]	3 (2)	0.3 (2)	17.3 (11)	21 (21)	0 (0)
Stylasteridae (Hydrocorals)	0 (0)	3.7 (4)	2.3 (3)	0 (0)	0.3 (1)
Echinodermata					
Asteroidea (Starfish)	1.0 (2)	11.7 (8)	4.0 (3)	30.0 (12)	3.3 (5)
Brisingida ('Armless' stars)	2.1 (5)	0 (0)	2.3 (2)	0 (0)	0.1 (1)
Crinoidea (Sea lillies)	3.8 (7)	1.7 (13)	3.5 (6)	20 (20)	0 (0)
Echinoidea (Sea urchins)	1037.2 (38)	215.9 (45)	52.5 (6)	80 (3)	19.3 (13)
Holothuroidea (Sea cucumbers)	17.5 (14)	19.6 (7)	0 (0)	0 (0)	7.6 (03)
Ophiuroidea (Brittle stars)	253.0 (70)	11.3 (16)	2.0 (1)	3.0 (3)	1.6 (3)
Mollusca					
Bivalvia (Mussles, clams)	0.2 (2)	0.7 (3)	0.1 (1)	0 (0)	0 (0)
Gastropoda (Snails, whelks, tritons)	1.8 (5)	6.1 (7)	0 (0)	0 (0)	0.2 (1)
Phaeophyceae (Brown algae)	10.0 (6)	0 (0)	0 (0)	0 (0)	0 (0)
Porifera (Sponges)[5]	191.9 (125)	428.5 (97)	168.5 (73)	15.4 (16)	22.9 (27)
Sipuncula (Peanut worms)	0 (0)	3 (1)	0 (0)	0 (0)	0 (0)
Unidentified	15.7 (7)	5.7 (5)	4 (4)	0 (0)	0 (0)

[251] Source: Fisheries New Zealand, 2021: "Weight in kg (and number of positive reports). Where taxonomic resolution allows, bycatch is presented at the Order level, otherwise at the Class or Phylum level. Row colours refer to VME indicator taxa included in CMM 03-2019 (purple), other VME indicator taxa added to CMM02-2021 (orange), and other benthic bycatch taxa (white)* This does not include the encounter event or weight . 1 includes taxa other than Actiniaria, Gorgonian, Alcyonacea, Scleractinia, Antipatharia, Pennatulacea, Zoanatharia, 2 Includes all Gorgonacea within the sub-orders Halaxonia, Calcaxonia and Scleraxonia, 3 Includes all taxa within the following genera: Solenosmilia; Goniocorella; Oculina; Enallopsammia; Madrepora; Lophelia, 4 Includes taxa other than Stylasteridae, and 5 Includes all Porifera within the classes Demospongiae and Hexactinellidae"

Australian waters and the high seas:

New Zealand-owned vessels also bottom trawl in the Indian Ocean under a Cook Island flag, and seasonally in Australia under a New Zealand flag, predominantly around Tasmania.

Benthic macrofauna research of small seamounts (300m - 600m high, with peaks ranging between 660m - 1,700m depth) south of Tasmania found high levels of fauna diversity[252]. One study found 262 species of invertebrates and 37 species of fishes and that the seamounts surveyed that had not been heavily fished and were shallower than 1,400m had dense and diverse invertebrate fauna including scleractinian corals, gorgonian and antipatharian corals, hydroids, sponges and sea stars[253]. This study supports similar findings to New Zealand that many seamounts have endemic, rare or even undiscovered species. Koslow et al (2001) found 24 - 43% of the invertebrate species sampled south of Tasmania were new to science and between 16 - 33% were restricted to the sampled seamount environment.



© CSIRO, 2018. Three kinds of stony corals and orange brisingid seastars. From seamount biodiversity study in the South West Pacific, on Tasmanian seamounts.

It is difficult to determine the exact impact New Zealand owned vessels are having in Australian waters, like the number of deep-sea coral species and other rare or endemic invertebrates that are being destroyed, as these vessels are not required to report coral bycatch in a similar way to within Aotearoa's EEZ.

[252] Koslow et al. 2001
[253] Koslow et al. 2001

What is known, is that seamounts off Tasmania support a diverse fauna associated with deep-sea reefs, formed by scleractinian corals like *Solemosmilia variabilis*[254]. These deep-sea scleractinian coral reefs are vulnerable to physical disturbance like bottom-trawling[255] and constitute VMEs. Most deep-sea corals surveyed around these Tasmanian seamounts live in water depths shallower than 1,500m[256]. This depth distribution makes them particularly vulnerable to deep-sea bottom trawling, which also occurs in waters shallower than 1,500m[257].

Deep-sea bottom trawlers operating on and near these Tasmanian seamounts, including New Zealand owned vessels are primarily targeting orange roughy[258]. Orange roughy are typically found between 700m – 1,200m[259] on or around seamounts in the region[260]. Williams et al. (2020) looked at the impact of bottom trawling on deep-sea coral reefs on 51 different seamounts and detected trawling damage on 88% (45 of 51) of seamounts[261]. This study found that depth of the seamount significantly affected the severity of the trawl damage. Shallower seamounts (those peaking < 950m depth) showed the greatest impact and deep-sea scleractinian coral reefs were reduced to rubble, comparatively to deep seamounts (where the summit depth is >1,500m) which generally exceeded the depth range of living deep-sea scleractinian corals and were also beyond the typical depth a bottom trawler operates showed the least signs of impact[262].

Section 4: Seamount protection

Almost half of Aotearoa's known seamounts (> 1,000m elevation) and associated biodiversity are at risk from bottom trawling (48% are open to bottom trawling while 52% are protected within Benthic Protected Areas (BPAs)[263]) and most other similar underwater features[264] are vulnerable to damage from bottom trawling as 72% of all such features (including seamounts >100m), are open to bottom trawling while only 28% are protected[265].

Is existing protection adequate?

The highest level of marine protection in Aotearoa are type 1 Marine Protected Areas (MPAs), known as no-take marine reserves. Aotearoa has 44 type 1 MPAs, which equates to less than 0.5%[266] of Aotearoa's entire EEZ[267] (Figure 24). No type 1 MPAs can be established beyond the territorial sea (12 nm) into the EEZ where the majority of seamounts occur.

[254] Duncan, 1873 described by Williams et al.2020.
[255] Clark & Rowden, 2009
[256] Williams et al. 2020
[257] Williams et al. (2020) reviewed commercial trawl logbook data and found there was no effort in waters deeper than about 1,500 m and on seamounts with peaks deeper than about 1,200 m
[258] Collette, 1889 described by Williams et al. 2020
[259] Edmonds et al. 1991
[260] Williams et al. 2020
[261] Williams et al. 2020
[262] Williams et al. 2020
[263] Ministry for Primary Industries, 2021
[264] Underwater topographic features include seamounts in many forms including hills and knolls.
[265] Ministry for Primary Industries, 2021
[266] 17,430km^2
[267] Department of Conservation, 2021

Aotearoa has closed approximately 1.1 million km^2 (~30%) of the EEZ to bottom trawling, known as BPAs and seamount closed areas[268], Figure 25 shows the BPAs. Fisheries New Zealand (2020) state "*Much of the seabed within BPAs is below trawlable depth (maximum trawlable depth is about 1600m) and all are outside the Territorial Sea. In combination, the seamount closures and the BPAs include: 28% of underwater topographic features (a term that includes underwater hills, knolls, and seamounts); 52% of seamounts over 1000m high; and 88% of known active hydrothermal vents*"[269].

BPAs protect seamounts and similar features from the impacts of bottom trawling but other fishing methods that do not contact the seafloor are permitted, such as long-lining and midwater trawl[270]. BPAs do not meet the protection standard for the New Zealand government's MPA Policy[271], and they would also fail to meet the lowest category in the internationally recognised IUCN marine protected area categories as they do not meet several of the criteria such as preventing mining or industrial fishing[272, 273].

Biodiversity knowledge from BPAs is limited, most BPAs have been sampled less than 100 times and are "*typically poorly described*"[274]. New species of invertebrates have recently been described from the Bounty Heritage BPA[275], which highlights that further work is needed to identify historic specimens, as there are likely to be new undescribed species. Clarke et al. (2019) recently compared certain species compositions inside and outside BPAs for the Chatham Rise between depths of 100m - 1000m and found that the BPAs had 27% of the known benthic invertebrate species from the Rise[276]. The same study stated that the BPAs effectiveness could be improved for biodiversity protection and also referred to similar findings from Leathwick et al (2008), Bors et al (2012) and Zeng et al (2017)[277].

©NIWA. Di Tracey and a large specimen of bubblegum coral (Paragorgia Arborea), New Zealand

[268] In 2001 the Government prohibited trawling on 17 seamounts, these are known as the seamount closed areas
[269] Fisheries New Zealand, 2020
[270] requires two observers are on board and an approved net monitoring system is used
[271] Lundquist et al. 2015
[272] Day et al. 2019
[273] In 2019 the then Minister of Conservation confirmed that the BPAs do not constitute marine protected areas nor count towards Aotearoa New Zealand's goals or commitments for marine protection. Vance, 2019
[274] Clark et al, 2019b
[275] Clark et al, 2014 found a new genus and 13 new species records of Porifera and 21 new species of Bryozoa described in Clark et al, 2019b
[276] Clark et al, 2019b
[277] Clark et al, 2019b

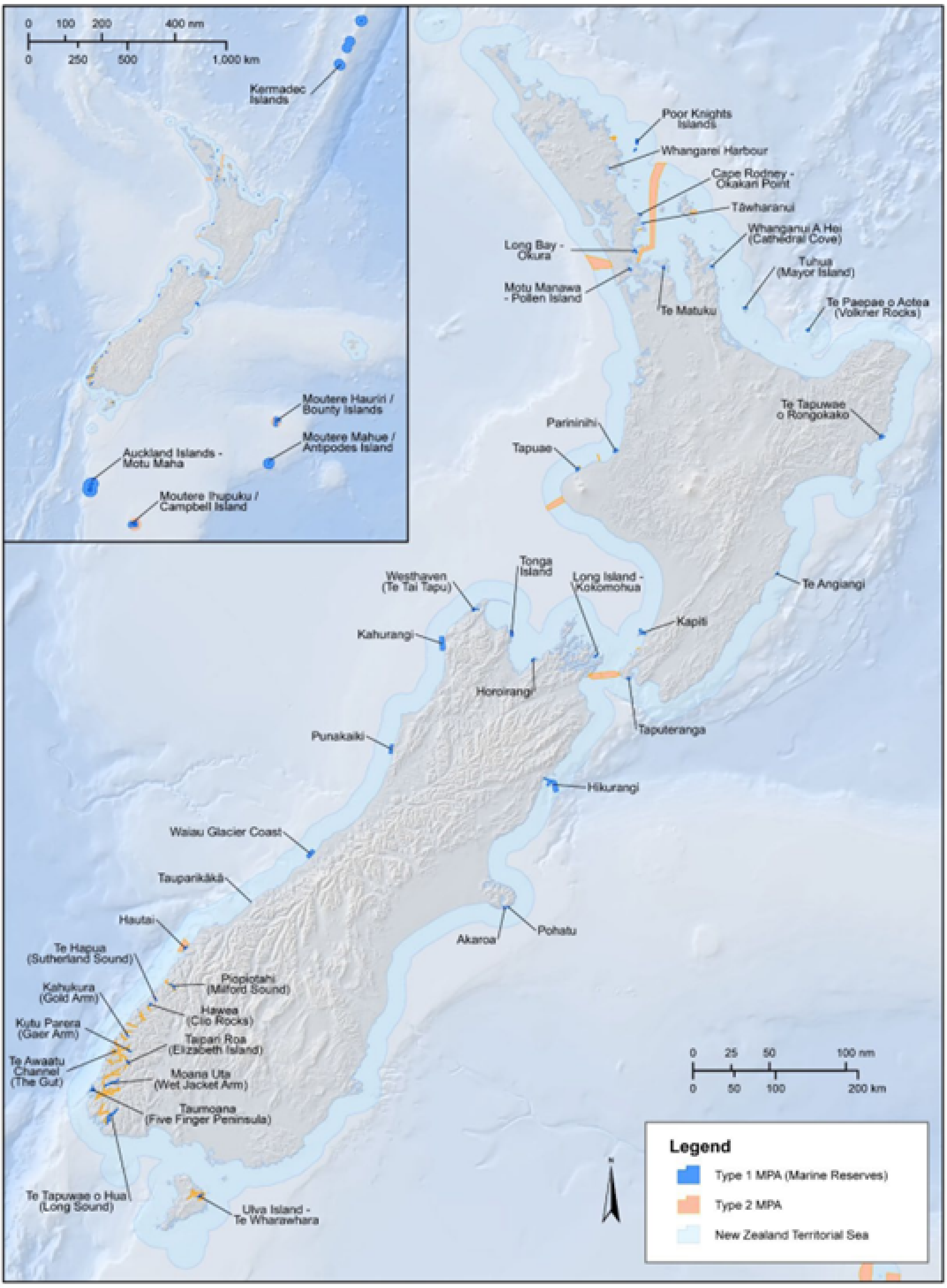


Figure 24: Marine Protected Areas in New Zealand - Type 1 (Marine reserves) and Type 2 MPAs, at December 2020
Source: DOC Information Services[278]

278 Department of Conservation, 2021

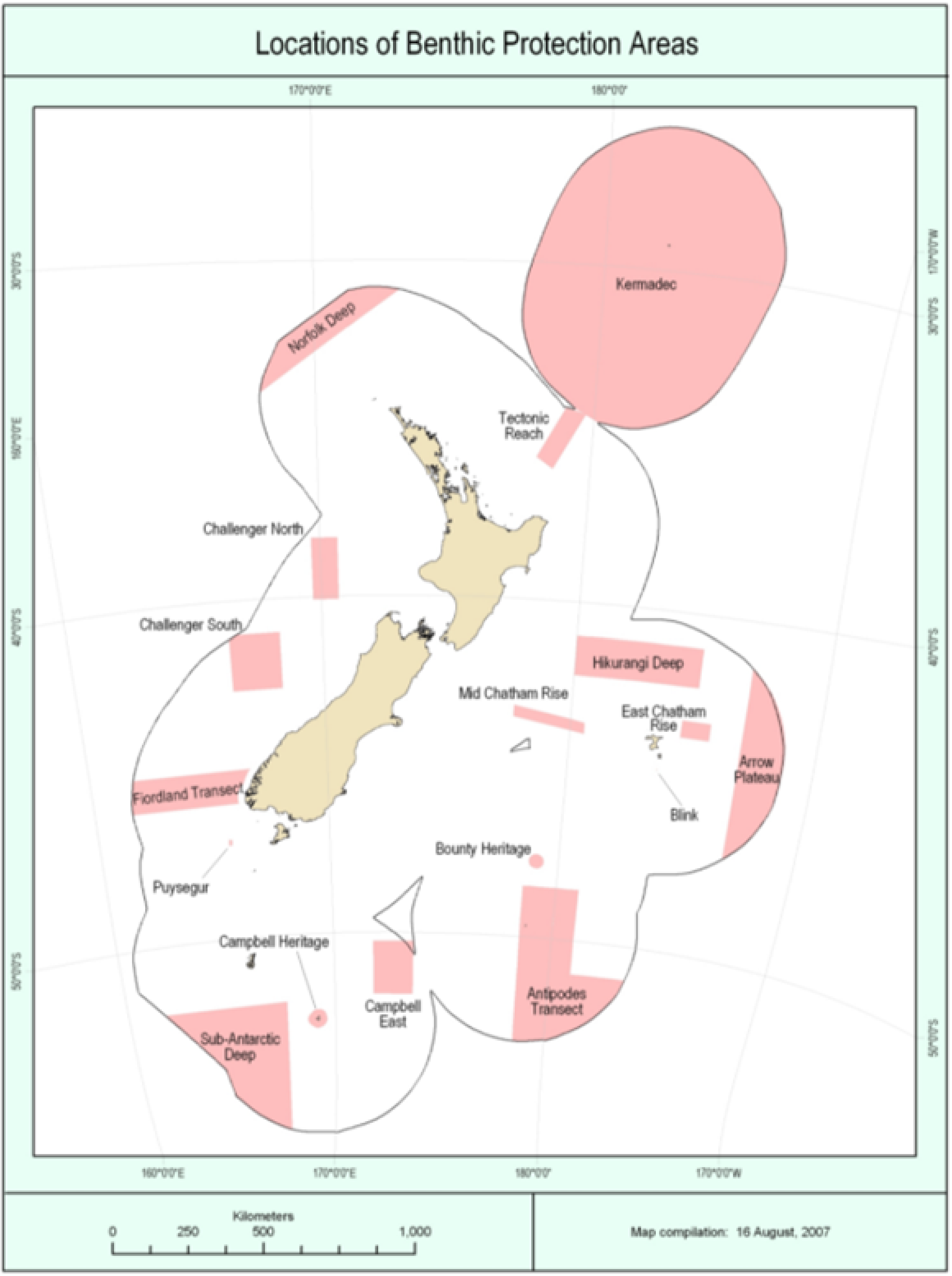


Figure 25: Map of Benthic Protected Areas within Aotearoa. Source: Fisheries New Zealand, 2009

Based on the depth distribution plots (Figures 5, 9, 11, 15 and 14) from Tracey & Hjorvarsdottir (2019), and what is known about the depths different protected and non-protected corals live, it can be generalised that most Aotearoa deep-sea coral taxa can be found between 200m - 1,000m [279], we refer to this as the 'core depth distribution' in this report.

Aotearoa deep-sea coral core depth distribution overlaps with 'fishable depths'. Deep water fisheries in Aotearoa generally operate between 200m - 1,200m (maximum trawable depth is 1,600m)[280], for example the main bottom trawl fishing depths for orange rough is between 800m – 1,200m[281].

Nine protected coral groups bycatch distributions were reviewed based on observers reports between 2007 - 2010. Protected coral was reported from a wide range of depths, the most common was from between 800m - 1200m, and came from target fisheries for orange roughy, black oreo, smooth oreo and black cardinalfish[282].

These deep-sea coral core depth distributions highlight that it's not the elevation of the seamount above the seafloor (>100m vs > 1,000m) that is a biological driving factor for these protected corals and other associated invertebrates, instead it's the depth from the surface. Specifically, if seamounts occur within the core depth distribution range for deep-sea corals, then the biodiversity associated with these seamounts and similar features are likely to increase. Given much of the "*seabed within BPAs is below trawlable depth (maximum trawlable depth is about 1600m)*[283]" it's likely not all these deep seamounts would support these protected deep-sea corals, as they are simply too deep.

FNZ estimates approximately 70% of the EEZ is deeper than 1,250m[284]. The 'fishable' area, defined as waters shallower than 1,600m within the territorial sea and EEZ excluding all BPAs, seamount closures and marine reserves is 34% of Aotearoa's waters[285]. This means 66% of the EEZ is deeper than 1,600m (excluding protected areas). Given this, and the depth restrictions of some corals, this means many species will also only be found within this 'fisable' area, the 34% or less of Aotearoa's waters.

The BPAs have been widely criticised for lacking in scientific basis related to their biodiversity value or species representativeness. Genetic research in Aotearoa, looking at two stony and two black coral species, which are both VME indicator taxa, found that the current unrepresentative deep-sea spatial seamount closures (BPAs) need to be improved[286]. Not all seamounts are currently protected in Aotearoa, which means not all genetic diversity of the invertebrates like corals are protected. Some deep-sea corals have limited connectivity[287] making them more vulnerable to benthic disturbances such as bottom trawling. Holland et al. (2020) found that the genetic diversity of corals on the Chatham Rise region (central region) is not well protected in BPAs and is one of the most heavily trawled areas.

279 Tracey & Hjorvarsdottir, 2019
280 Fisheries New Zealand, 2020
281 Deep Water Group Limited, 2021
282 Baird et al, 2013
283 Fisheries New Zealand, 2020
284 Fisheries New Zealand, 2019
285 Black & Tilney, 2017
286 Holland et al. (2020)
287 Holland et al. 2020

Existing BPA protection is not preventing the potential loss of deep-sea biodiversity that hasn't even been discovered. A recent government workshop stated that new coral species are still being identified because global taxonomic experts are still reviewing historic samples and commercial fishing vessels are still going to new areas which means encountering new species that scientists didn't even know existed[288]. Some of these new species come from seamounts.

WWF-NZ (2021) found that in the ten years from 2009 to 2019 3,280 km^2 of the seabed was bottom trawled for the first time. This is an area more than three times the size of Auckland (1,086 km^2)[289]. Over the past decade, most of the newly trawled areas (around 75%) were from inshore fisheries, however in 2019 85.7 km^2 of deep-sea was newly trawled and 62.3km^2 of inshore waters.

FNZ concluded that the overall trawl footprint when comparing 2007/08 to 2017/18 against 1989/90 to 2006/07 is decreasing "*after a peak period from 1998 - 2003 (Baird & Wood 2018), and has stablised, at a lower level in recent years*"[290]. This statement does not reflect that while the annual footprint may be smaller, it has increasingly consisted of new areas that have never been trawled before and therefore the cumulative footprint of the seabed within 'fishable' depths that have been trawled one or more times within Aotearoa is actually still expanding.

There is limited data available on deep-sea coral biology, productivity and even endemism. What is known, is that Aotearoa is home to a diverse range of deep-sea corals that are widely distributed, some are highly endemic and rare, and in general deep-sea corals tend to occupy a broad depth range from shallow waters to well over 2,000m deep, but many taxa usually have a core depth range of between 200 – 1,000m depth[291] and are associated with seamounts within 'fishable depths'. The VME locations (Figure 4) compared to the BPAs, highlights the vulnerability of those VMEs outside of existing protected areas.

The Environment Select Committee (ESC) is currently reviewing a request presented by the Deep Sea Conservation Coalition on behalf of Aotearoa eNGOs and fishing groups[292] to ban bottom trawling on all seamounts within Aotearoa's EEZ and a request for the Government to stop issuing high seas permits to New Zealand companies bottom trawling beyond Aotearoa's EEZ in areas like SPRFMO. At the date of this publication the ESC had not made their recommendation to the government and were still reviewing all the evidence received[293].

Understanding the biological value of the 100m seamount elevation classification versus the 1,000m is important given the submission to the Environment Select Committee (ESC) by the Deepwater Group (DWG), an alliance of deepwater quota owners in response to the DSCC. The DWG submission states that the definition of a seamount is "*an underwater feature with an elevation of more than 1,000 meters"* and in terms of New Zealand, refers to the use of this elevation by New

[288] Tracey & Hjorvarsdottir, 2019 - Appendix 4:.
[289] WWF-NZ, 2021
[290]Baird & Mules (2020a, in review) described in Fisheries New Zealand, 2020
[291] Tracey & Hjorvarsdottir, 2019
[292] Coalition includes: Deep Sea Conservation Coalition, Environment and Conservation Organisations (ECO), Greenpeace Aotearoa, Forest & Bird, LegaSea, New Zealand Sports Fishing Council, Our Seas Our Future and WWF-New Zealand
[293] All evidence of the Petition of Karli Thomas, on behalf of the Deep Sea Conservation Coalition and its member groups: Save deep sea corals - ban bottom trawling on seamounts can be found here: Submissions and Advice - New Zealand Parliament (www.parliament.nz)

Zealand Geographic Board, New Zealand's naming authority. The DWG did not refer or quote DOC and FNZ's joint evidence to the ESC which was discussed in Section 1.

DOC and FNZ evidence highlights that the "*IUCN Atlas of Mediterranean Seamounts defines seamounts and seamount-like structures as all elevations that rise more than 100 meters from the surrounding seafloor*" and "*that the physical characteristic of small seamounts-like features less than 1,000 meters above the seafloor affect biology in very similar ways to large seamounts greater than 1,000 meters above the seafloor*"[294]. In their joint evidence, FNZ and DOC use the elevation of 100m above the seafloor to describe seamounts and seamount-like features[295].

Can protection work?

Research following fisheries closures on Aotearoa and Australian seamounts after 5 and 10 years respectively found no change, suggesting that recovery in benthic community structure to pre-disturbed state on seamounts can take decades to centuries[296] because of the slow growth rates and high longevity of a number of invertebrates such as corals[297].

The most recent time-series study from Aotearoa looking at the impacts of bottom trawling and recovery of benthic communities surveyed seamounts from the Graveyard Knolls seamount group (Figure 26). The Graveyard Knolls seamounts comprises of 28 small volcanic cone features typically between 100 - 400 m high, rising from depths of 1,050 - 1,200m to summit depths of 750 - 1,000m[298]. A trawl fishery for spawning orange roughy began on the Graveyard Knolls in the early 1990s, with most effort on two features, "Morgue" and "Graveyard"[299]. In 2001 "Morgue" was closed. The study surveyed six of these seamounts representing a range of trawl histories, one with high and persistent trawling levels, two with intermediate trawling, two with low trawling or 'untrawled' during the survey and one closed[300]. Clark et al. (2019) found the communities of organisms that lived on seamounts prior to fishing activities showed no sign of recovery, even though the seamounts had not been fished for at least 15 years[301].

These studies confirm the vulnerability of slow growing, high longevity invertebrates, like corals and the low resilience benthic communities on seamounts[302] and similar underwater features have to the effects of benthic disturbance like bottom trawling.

An international study of shallower seamounts than these, in the northwest Hawaiian Ridge and southern Emperor Seamount Chain, found some indications of coral recovery 30 years after they were protected from trawling in the 1970s and 1980s[303].

These results are significant because they confirm that regeneration of deep-sea coral communities on seamounts may be possible but require longer 30-40 year time scales[304].

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294 Department of Conservation & Fisheries New Zealand, 2021
295 Department of Conservation & Fisheries New Zealand, 2021
296 Williams et al. 2010
297 Clark et al. 2019
298 Clark et al. 2019
299 Clark et al. 2019
300 Clark et al. 2019
301 Clark et al. 201
302 Williams et al. 2020
303 Baco et al. 2019
304 Baco et al. 2019

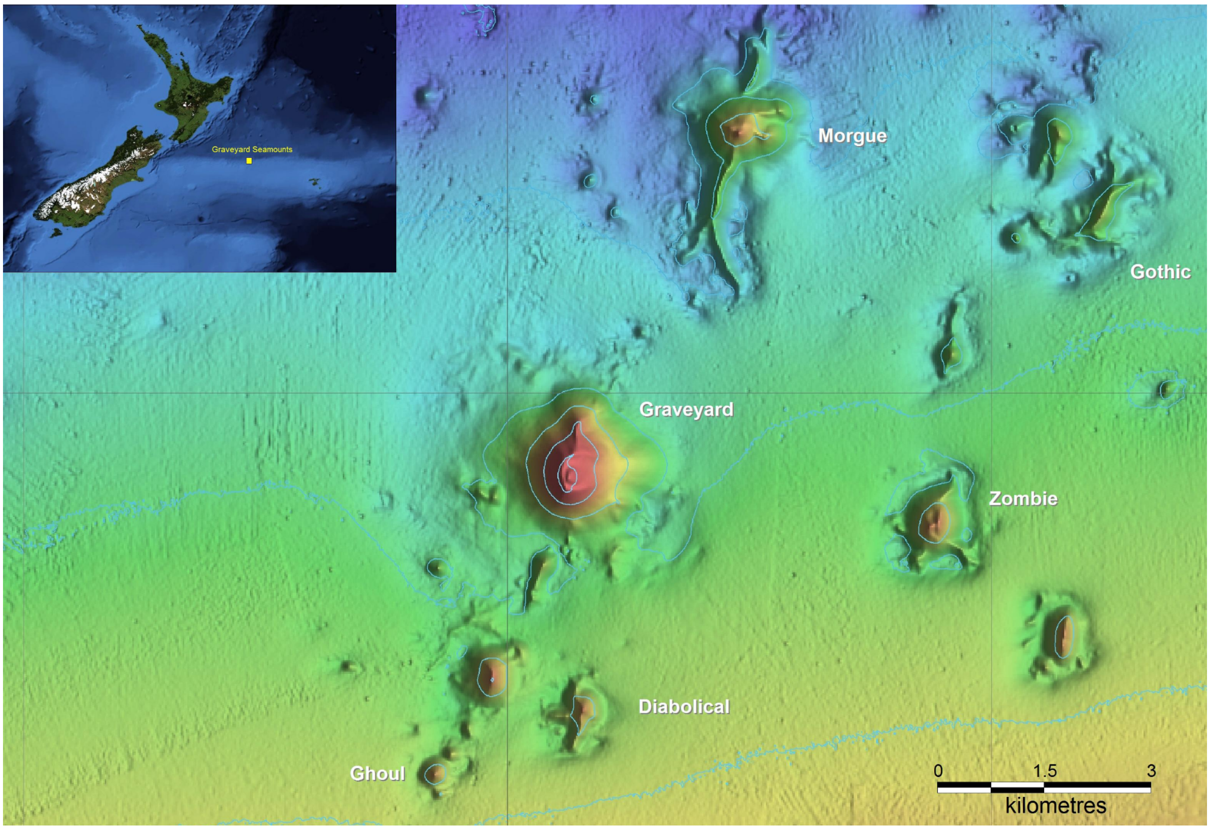
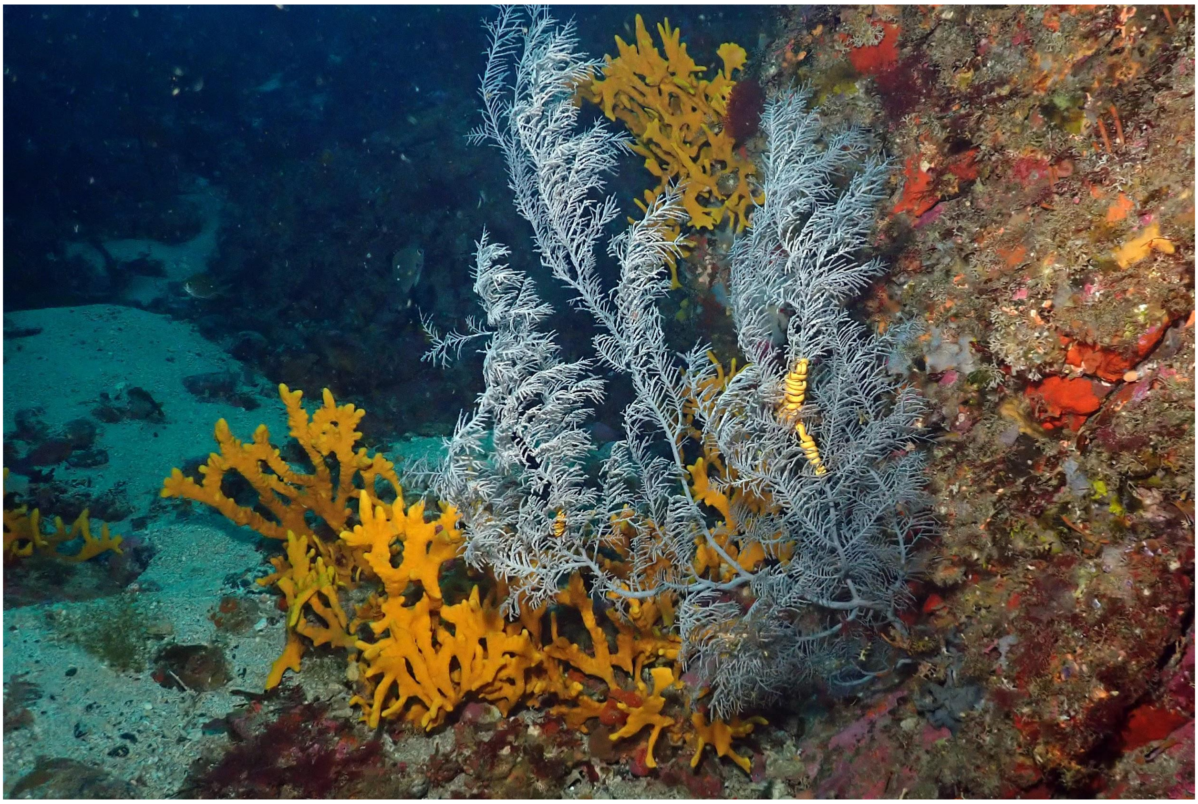


Figure 26: Shows the Graveyard Knolls, a group of small seamounts and features located east of Aotearoa. Source: Clark et al. 2019



© Andy Stewart. Black coral, Hen & Chickens Islands, Northland New Zealand, 2021

Acronyms and Abbreviations:

ANZBS	Te Mana o te Taiao Aotearoa New Zealand Biodiversity Strategy 2020
BPAs	Benthic Protected Areas
DOC	Department of Conservation
DWG	Deepwater Group Limited
EEZ	Exclusive Economic Zone (offshore to 200 nautical miles)
ESC	Environment Select Committee
FAO	Food and Agriculture Organisation of the United Nations
FMA	fisheries management area
FNZ	Fisheries New Zealand
RFMO	Regional Fisheries Management Organisations
SAI	significant adverse impact
SPFRMO	South Pacific Regional Fisheries Management Organisations
TS	Territorial Sea (0-12 nautical miles)
UNCLOS	United Nations Convention on the Law of the Sea
UNGA	United Nations General Assembly
VME	Vulnerable Marine Ecosystems

Key Definitions:

Seamount: Seamounts are underwater mountains that rise more than 100m above the surrounding seafloor, where the seafloor is more than 200 metres below the surface [305].

The FAO definition is "*A large isolated elevation characteristically of conical form. Seamounts are under-sea mountains whose summits lie beneath the ocean surface. They are usually volcanic in origin and are generally defined as having an elevation of greater than 1 000 metres from the seabed*"[306].

Knolls: Relatively small (500 to 1000 m tall) isolated elevation of a rounded shape

Guyots: A seamount with a truncated, flat top surface[307].

VME: Vulnerable marine ecosystems (VMEs) are those ecosystems highly vulnerable to one or more kinds of human activity such as fishing. VMEs are identified by the vulnerability of their species, communities, and or habitats to disturbance. A VME is described in the Deep-sea Fisheries Guidelines by its characteristics and by its vulnerability[308].

SAI: "negative effects on a VME resulting from damage caused during the operation of bottom-contact fishing gear. The scale and significance of the impact determines whether the impact can be considered an SAI. This occurs when the ecosystem function is impaired and the long-term natural productivity degraded on more than a temporary basis. Ecosystem recovery following impacts is case-by-case dependent, but is considered more than temporary if recovery takes more than 5 – 20 years."[309]

[305] Rogers, 2018
[306] Cochrane, 2002
[307] Pitcher et al., 2007
[308] FAO, 2009; Definitions | Vulnerable Marine Ecosystems | Food and Agriculture Organization of the United Nations (fao.org)
[309] FAO, 2009

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