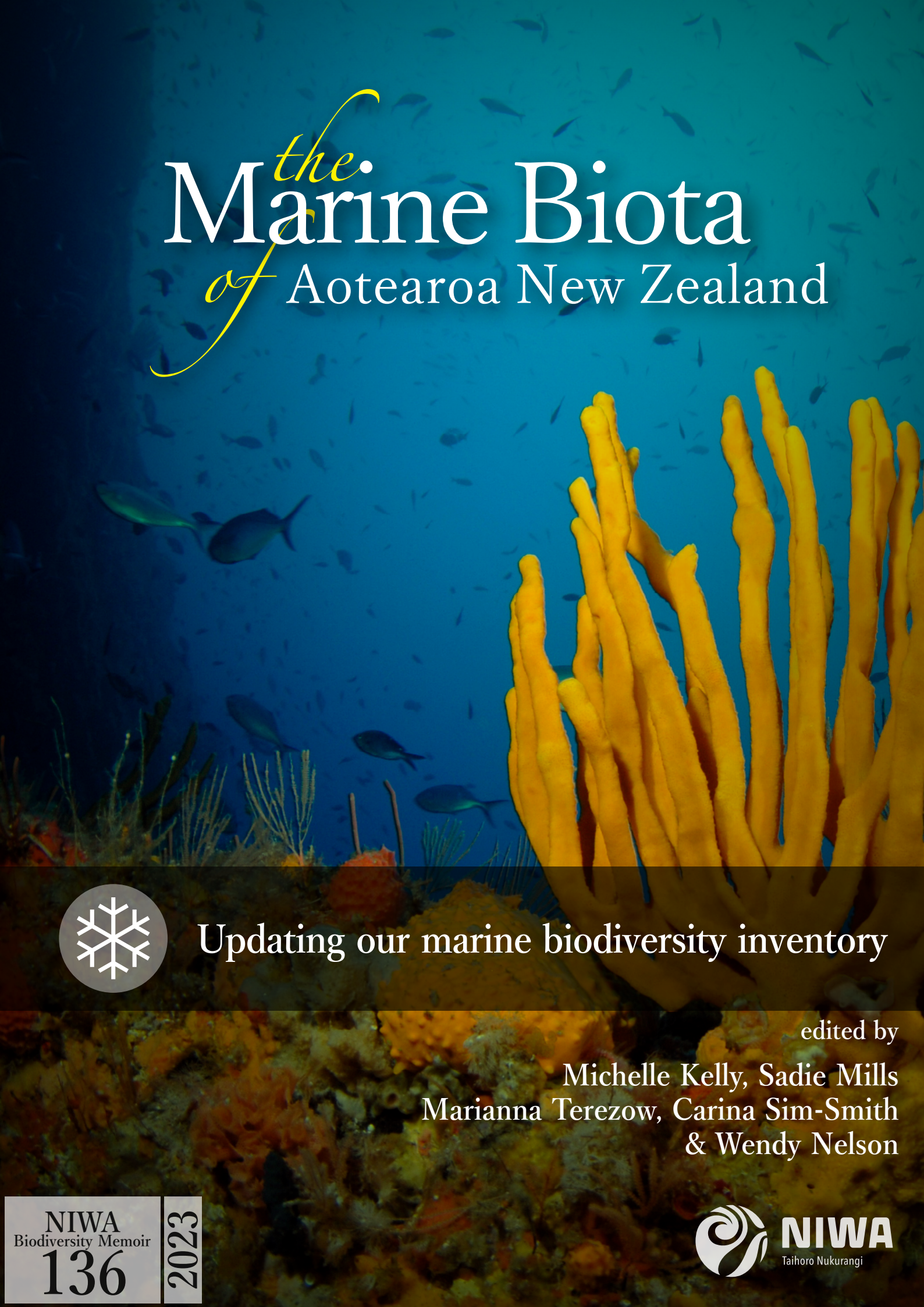

the Marine Biota of Aotearoa New Zealand

Updating our marine biodiversity inventory

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Updating our marine biodiversity inventory

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Abstract

Over twenty years have passed since the first inventory of Aotearoa New Zealand's biodiversity was initiated, within the global millennial project, Species 2000 New Zealand. This immense undertaking culminated in the publication of three volumes reviewing New Zealand's entire known inventory of animals, plants, fungi, and microorganisms, covering all life in all environments, from the Cambrian to the present day (Gordon (Ed.) 2009, 2010, 2012). The impetus to update the inventory of New Zealand's marine biodiversity came in the year 2020, effectively two decades after the New Zealand Inventory of Biodiversity was conceived, and coinciding with the World Conference on Marine Biodiversity (WCMB), held in Auckland in December 2020. Over the ensuing three years, sixty-five taxonomic experts from various national and overseas institutions revised and updated the inventory of their marine groups of interest, and summarised the status of knowledge on these taxa, to the date of publication. The geographic scope includes the New Zealand Exclusive Economic Zone (EEZ) and the wider New Zealand region encompassing the outer limits of the Extended Continental Shelf (ECS) and surrounding International Waters, occurring between 25° S and 56° 30' S, and 158° E and 170° W.

Thirty-three chapters review and update the inventory of a range of marine phyla including: Opisthokonta-Holozoa (choanoflagellates and holozoan parasites); Kingdom Chromista (phyla Foraminifera and Ochrophyta); Kingdom Plantae (phyla Prasinodermatophyta, Chlorophyta, and Rhodophyta); Kingdom Animalia (phyla Acanthocephala, Annelida, Arthropoda (Crustacea, Insecta, and Pycnogonida), Brachiopoda, Bryozoa, Chordata (Ascidiacea, Appendicularia, Aves, Mammalia, Reptilia, Thaliacea, and marine fishes), Cnidaria, Ctenophora, Dicyemida, Echinodermata, Gastrotricha, Gnathostomulida, Kinorhyncha, Loricifera, Mollusca, Nematoda, Nemertea, Phoronida, Platyhelminthes, Porifera, Priapulida, Rotifera, Tardigrada, and Xenacoelomorpha).

Of the 73 taxonomic groups reviewed in Gordon (Ed.) (2009, 2010, 2012), 28 groups have not been formally reviewed in this volume. This is because several groups are beyond the general scope of this work (marine), being entirely terrestrial or freshwater inhabitants, or being single-celled (Foraminifera and Opisthokonta-Holozoa excepted). For some groups, there are still no marine species recorded from the New Zealand region, and for others, no one was available to provide an update. Minor updates have been provided in Preface Table 1 for Kingdoms Bacteria, Chromista (Oomycota), and Fungi (Basidiomycota) (B. Weir & J. Cooper, pers. comm.).

Each chapter contains checklists of extant and fossil (where applicable) taxa, and a table that summarises species diversity numbers for the phylum under consideration, representing our current knowledge status of the biodiversity of extant and fossil marine biota of the New Zealand region. The checklists are usually arranged according to the currently accepted systematics and classificatory scheme employed by the World Register of Marine Species (WoRMS) (http://www.marinespecies.org/), or taxon-specific databases associated with WoRMS, as unique to each taxon. The specimens that form the basis of the checklists in each chapter are either formally described taxa or taxonomically indeterminate taxa called operational taxonomic units (OTU), in national, international, and personal collections, and some may have been based upon images only, from Remote Operated Vehicles (ROV) or deep-sea imaging systems such as NIWA's Deepsea Towed Underwater Imaging System (DTIS). Metadata surrounding the updated checklists of marine taxa will be made available online as a supplementary dataset, making it available to national and international databases.

Keywords

Acanthocephala, Animalia, Annelida, Appendicularia, Ascidiacea, Aves, bony fishes, Brachiopoda, Bryozoa, cartilaginous fishes, Chlorophyta, Choanoflagellatea, Chordata, Chromista, Cnidaria, Crustacea, Ctenophora, Dicyemida, Echinodermata, Foraminifera, hagfishes, Ichthyosporea, lancelets, Gastrotricha, Gnathostomulida, Insecta, Kinorhyncha, Loricifera, macroalgae, Mammalia, Mollusca, Nematoda, Nemertea, Ochrophyta, Opisthokonta-Holozoa, otoliths, Phaeophyceae, Phoronida, Plantae, Platyhelminthes, Porifera, Prasinodermatophyta, Priapulida, Pycnogonida, Reptilia, Rhodophyta, Rotifera, Tardigrada, Thaliacea, Tunicata, Xenacoelomorpha, marine biodiversity, marine biota, extant, extinct, fossils, operational taxonomic units, unicellular lineages, taxonomically indeterminate taxa, inventory, metadata, Aotearoa New Zealand, New Zealand Exclusive Economic Zone, Extended Continental Shelf

Introduction

Wendy A. Nelson

Aotearoa New Zealand is situated in the South Pacific region, the largest ocean space in the world, home to many varied ecosystems, and covering almost one-third of the Earth. For a relatively small country, New Zealand has a long coastline (ca. 20,500 km including mainland and offshore islands), and jurisdiction over a very large area of sea (Fig. 1). The New Zealand Exclusive Economic Zone (EEZ) and the Extended Continental Shelf (ECS) are approximately 21 times the New Zealand landmass above water (Environment Foundation 2018).

The Inventory of New Zealand Biodiversity, presented in the Gordon (Ed.) (2009, 2010, 2012) volumes, was a global 'first' in its scope. A decade on, the present volume updates the inventory for the marine biota, and provides an opportunity to evaluate the progress we have made in discovering and documenting our flora and fauna. The discovery, characterisation and naming of New Zealand's marine biota provides the framework for understanding life in our coastal and extensive marine zone, enabling us to manage and protect our resources. This volume contributes to international biodiversity initiatives e.g., the United Nations Decade on Biodiversity (2011–2020), and the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). Science generated by the taxonomic community is essential for progress on these goals.

Within New Zealand there have been two major strategic reviews in the past decade focused on taxonomy. The Royal Society Te Apārangi carried out a de-

tailed examination of the status of New Zealand taxonomic collections and associated activities in museums, Crown Research Institutes (CRIs) and universities (Nelson *et al.* 2015). That review acknowledged that taxonomy and natural history collections are national heritage assets, and essential components of the New Zealand science system that underpin a wide range of public and private benefits such as environment, health, culture, heritage, biosecurity, and the economy. In 2018, a joint plan developed under the auspices of the Australian Academy of Science and the Royal Society Te Apārangi, "Discovering Diversity: a decadal plan for taxonomy and biosystematics in Australia and New Zealand 2018–2028" was published, presenting a vision for the disciplines of taxonomy and biosystematics in Australia and New Zealand (Taxonomy Decadal Plan Working Group 2018). As noted by Sir David Attenborough in the Foreword to the Plan, "*Taxonomists and biosystematists build the system, the species and their relationships, on which much of biology, conservation, ecology – and nature documentaries – depend. We cannot properly grasp or understand the natural world without this taxonomic system. Every time I show the world a species and its life, I depend on the work of these scientists. And yet, in countries the world over, at the very time that many species are under greatest threat, funding and other resources allocated to the task of discovering, naming and documenting nature are declining*".

"Te Mana o Te Taiao: Aotearoa New Zealand Biodiversity Strategy", was released in 2020 (DOC 2020a), with the accompanying report, "Biodiversity in Aotearoa – an overview of state, trends and pressures" (DOC 2020b). In that report it was noted that nearly half of the marine species evaluated to date for their conservation status (e.g., Duffy *et al*. 2018; Baker *et al.* 2019; Nelson *et al.* 2019a; Robertson *et al.* 2021; Funnell *et al*. 2023) have been assessed as "data deficient" with a significant proportion either "at risk" (32%) or "threatened" (4%). The report also noted that the level of knowledge of many marine ecosystems was incomplete, and thus their status and the scale of change or loss in biodiversity and ecosystem functioning is unable to be evaluated. The report concluded that more effort is required to "*document the identity, abundance and distribution of New Zealand's marine biodiversity, and there is a need to better understand the links between biodiversity and ecosystem function in marine communities*". Many of our most productive marine biogenic habitats (habitats created by living plants or animals) are highly vulnerable to the impacts of human activities (Anderson *et al.* 2019). Data confirm that in New Zealand there are examples of significant degradation, decline in extent and function, as well as loss of some of these habitats, which in turn can cause wider ecosystem collapse. Biodiversity loss has been shown to reduce primary and secondary productivity, ecosystem stability, and nutrient and energy fluxes, which all negatively affect ecosystem functioning (Cardinale *et al.* 2012; Zhang *et al.* 2022).

The Intergovernmental Science-Policy Platform on Biodiversity & Ecosystem Services Global Assessment (IPBES 2019) identified that the five most significant direct drivers of major change in global and local biodiversity for marine ecosystems and species are direct exploitation of organisms, changes in land and sea use, climate change, pollution, and invasion of non-indigenous species. The impacts of all of these drivers can be seen in New Zealand waters and have been identified as key threats to New Zealand's marine habitats and biodiversity (MacDiarmid *et al*. 2012).

Collectively, the progress in documentation of the marine biota is impressive. Since the publication of the New Zealand Inventory of Biodiversity, there have been significant advances in collection management, storage, and staffing in some natural history collection holding institutions. Auckland Museum Tāmaki Paenga Hira invested in a major project to tackle specimen backlogs, greatly increasing the accessibility of material. The NIWA Invertebrate Collection (NIC) has continued to address recent and backlog specimen registration, and through its continuing networks with global experts has continued to make taxonomic progress with taxon groups where there are no local specialists.

New collections have been made from a number of different parts of the New Zealand region as a result of a range of research programmes focusing on, for example, abyssal depths, vulnerable marine ecosystems, biogenic habitats, and biodiversity surveys targeted to meet local and regional priorities. Valuable collections have been obtained as a result of by-catch from research trawl surveys and commercial fisheries. In addition, targeted research programmes on specific taxon groups have yielded collections and associated data that have transformed our understanding of particular groups (e.g., coralline algae, Twist *et al.* 2019; invertebrate communities and associated microbiomes, Schupp *et al*. 2017). These new collections have enabled a greater understanding of the marine diversity of the New Zealand region. The increased knowledge about the marine biota is being applied in a diversity of ways – as well as contributing to systematics knowledge, these studies are key to characterising important habitats and ecosystems in the New Zealand region, and the new knowledge has been able to contribute to a wide range of research programmes and policy initiatives.

In the last decade, numerous key biodiversity works have been published, including: 1) The award-winning Fishes of New Zealand, a four-volume treatment of the fauna (Roberts *et al.* (Eds) 2015), with multiple national and international collaborators, edited by the Te Papa fish team; 2) The NIWA Biodiversity Memoir series (https://niwa.co.nz/oceans/niwa-biodiversity-memoirs/about), with thirteen volumes published since

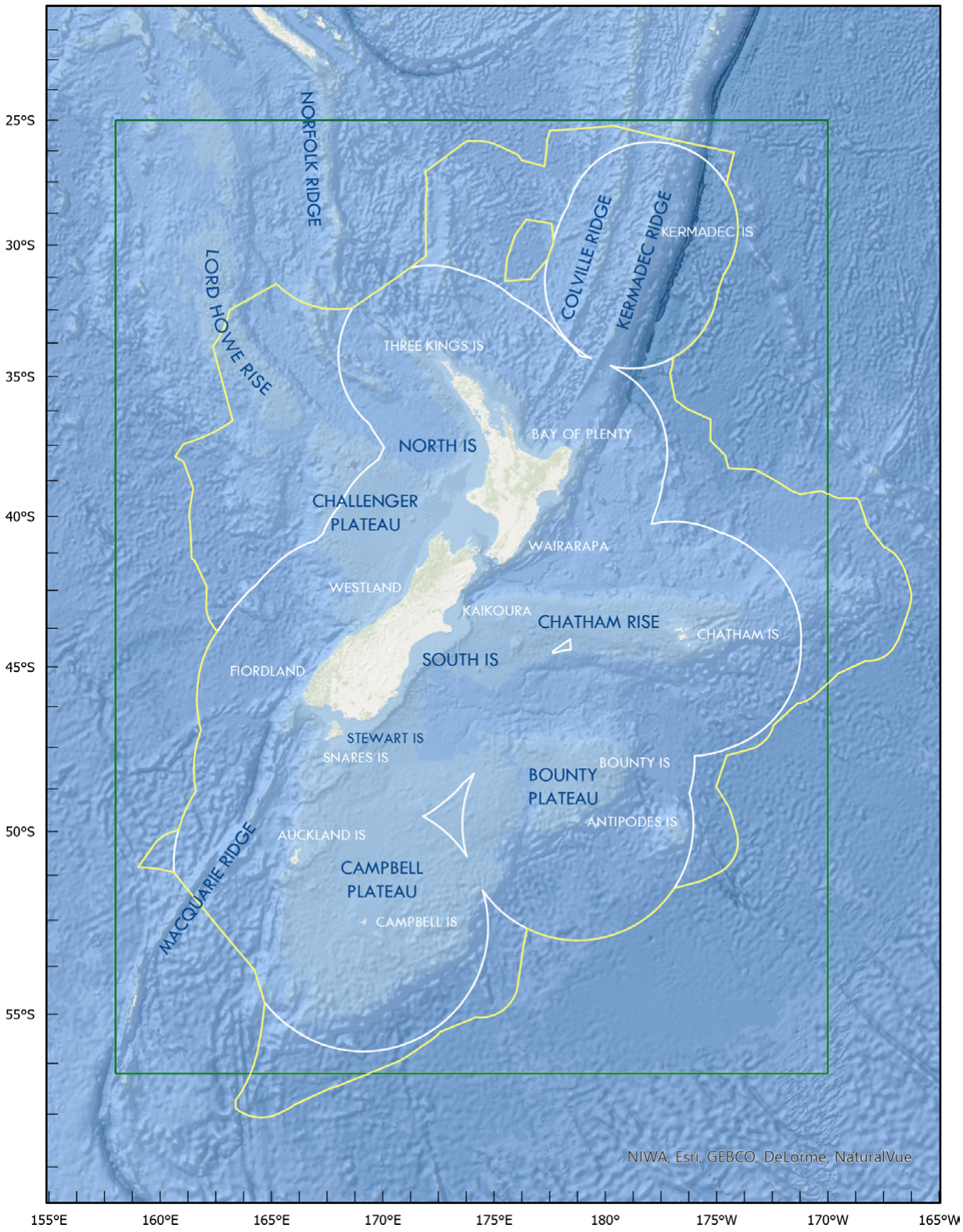

Figure 1. Major features of Aotearoa New Zealand's marine realm. The white line shows New Zealand's EEZ; the yellow line shows the Outer Limits of the Extended Continental Shelf (ECS), which ranges from the northern Norfolk Ridge at 26.4° N (north of Norfolk Island) to the Hjort Seamount and southern end of Hjort Trench at 59° S, and eastwards to a remote seamount in the Louisville Seamount chain at 169° W. The Extended Continental Shelf is a well-defined legal boundary. The green line corresponds to the Extended New Zealand region (E2), as defined by Roberts *et al.* (2015), occurring between 25° S and 56° 30' S, and 158° E and 170° W.

2009, providing monographic treatment of a diverse range of groups including amphipods, isopods, squat lobsters, mantis shrimps, and king crabs, sponges, nematodes, coccolithophores, and primnoid corals. These comprehensive, definitive, peer-reviewed volumes capture critically important information about New Zealand's distinctive marine biota; 3) Reviews of habitat forming organisms that provide critical biogenic habitats and serve as ecosystem engineers supporting high diversity in their respective ecosystems e.g., deep-sea corals (Tracey & Hjorvarsdottir (Eds, Comps) 2019); and coralline red algae (Nelson *et al.* 2019b); 4) A range of guidebooks and marine biota e-guides have been produced to make information about marine biota accessible to non-specialist audiences (https://niwa.co.nz/oceans/resources/marine-identification-guides-and-fact-sheets).

As reflected in the Gordon (Ed.) volumes, progress in documenting the marine biota in New Zealand has been heavily reliant on networks of collaboration with international colleagues, and a number of chapters in this memoir have been authored by global experts where no current capacity is present in New Zealand. The chapters in this volume are based on natural history collections housed in a range of New Zealand institutions and authored by local taxonomists and parataxonomists (identification specialists) as well as international colleagues. Each of the stand-alone 33 chapters reviews and updates the inventory of marine phyla including: Opisthokonta-Holozoa (choanoflagellates and holozoan parasites); Kingdom Chromista (phyla Foraminifera and Ochrophyta); Kingdom Plantae (phyla Prasinodermatophyta, Chlorophyta, and Rhodophyta); Kingdom Animalia (phyla Acanthocephala, Annelida, Arthropoda (Crustacea, Insecta, and Pycnogonida), Brachiopoda, Bryozoa, Chordata (Ascidiacea, Appendicularia, Aves, Mammalia, Reptilia, Thaliacea, and marine fishes), Cnidaria, Ctenophora, Dicyemida, Echinodermata, Gastrotricha, Gnathostomulida, Kinorhyncha, Loricifera, Mollusca, Nematoda, Nemertea, Phoronida, Platyhelminthes, Porifera, Priapulida, Rotifera, Tardigrada, and Xenacoelomorpha).

Figure 2 illustrates the number of described, and known undescribed, extant species for each group treated in this volume, showing that for most of the taxa inventoried, well over half of the species are formally described. All undescribed taxa listed in the checklists as operational taxonomic units (OTU) are referenced to a traceable collection accession number or authority, allowing precise species counts to be produced (see the first table in each chapter), providing a remarkable baseline resource for ongoing planning and research.

Figure 3 illustrates collective progress in taxonomy, presenting the numbers of extant taxa recognised in the earlier inventory (Gordon (Ed.) 2009, 2010, 2012) with the taxa recognised in this volume, showing that progress has ranged from over 70, 80, and 130% increase in the total number of extant species for Porifera, Brachiopoda and Nematoda, respectively, to a loss of 25% of extant species in minor taxa such as Loricifera and Priapulida, due to revisionary work. The variability of progress across all groups is strongly linked to funding for systematics, and the availability of taxonomic expertise. In the groups where there are taxonomists employed to conduct systematic research (e.g., marine fishes, Crustacea, Porifera, Mollusca, macroalgae), there have been steady increases in knowledge, with substantial increases in numbers of recognised species in some groups (e.g., Porifera, Nematoda). Taxonomic expertise in other groups sits with emeritus or retired specialists who continue to make very significant contributions to the documentation of the biota (e.g., Bryozoa, Mollusca, Foraminifera, Annelida). In other areas, the expertise resides with parataxonomists who have extremely limited time and resources to progress taxonomic work, and yet make sustained and important contributions to understanding the groups they work on (e.g., Echinodermata, Tunicata), or with a combination of parataxonomists, and local and global specialists (e.g., Cnidaria).

Some of the smaller groups have received very little attention to date, with few collections available for investigation (e.g., Dicyemida, Gastrotricha, Nemertea, Rotifera). It is clear that in some cases there is a strong likelihood that further discoveries will result following targeted collections coupled with taxonomic study by young, active taxonomists (e.g., Ctenophora, Kinorhyncha, Loricifera). The use of molecular methods has had a significant impact on the recognition of previously overlooked or cryptic species, for example, in the Platyhelminthes. Molecular methods have also been crucial to understanding in the marine macroalgae where there have been very significant changes in higher-level systematics resulting from phylogenetic analyses produced over the past decade. In each of the chapters, the authors have evaluated various aspects of the taxon group, some including consideration of the as-yet undiscovered diversity. In the case of the Crustacea, the authors note *"despite the considerable progress made in the last decade, the potential for new species discoveries remains extremely high with little indication of the New Zealand species richness curve reaching a plateau"*.

In addition to listing the extant biota, the fossil marine taxa are also compiled in the relevant taxon groups, providing an important baseline for past biodiversity, evolution, and extinction rates. Fossils can be used to ground-truth climate change models by adding real-life data points of how species behaved under differing climatic and environmental conditions (Naish *et al.* 2012). Figure 4 presents the fossil taxa by taxon group. In some groups, the numbers of fossil taxa exceed the known extant fauna (e.g., Mollusca), and in some cases this is by a considerable margin, e.g., the fossil fauna of Brachiopoda is over 90% of total known species recognised from New Zealand.

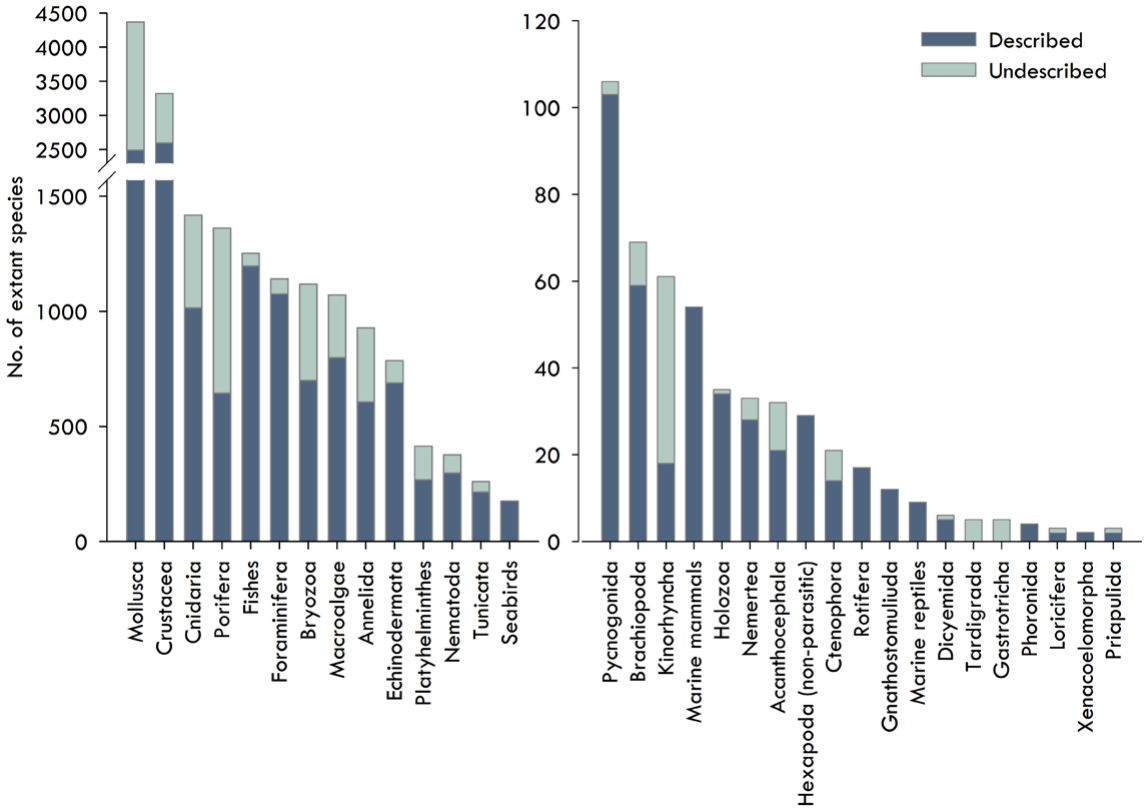

Figure 2. Number of described, and known undescribed, extant marine species for taxon groups in this volume.

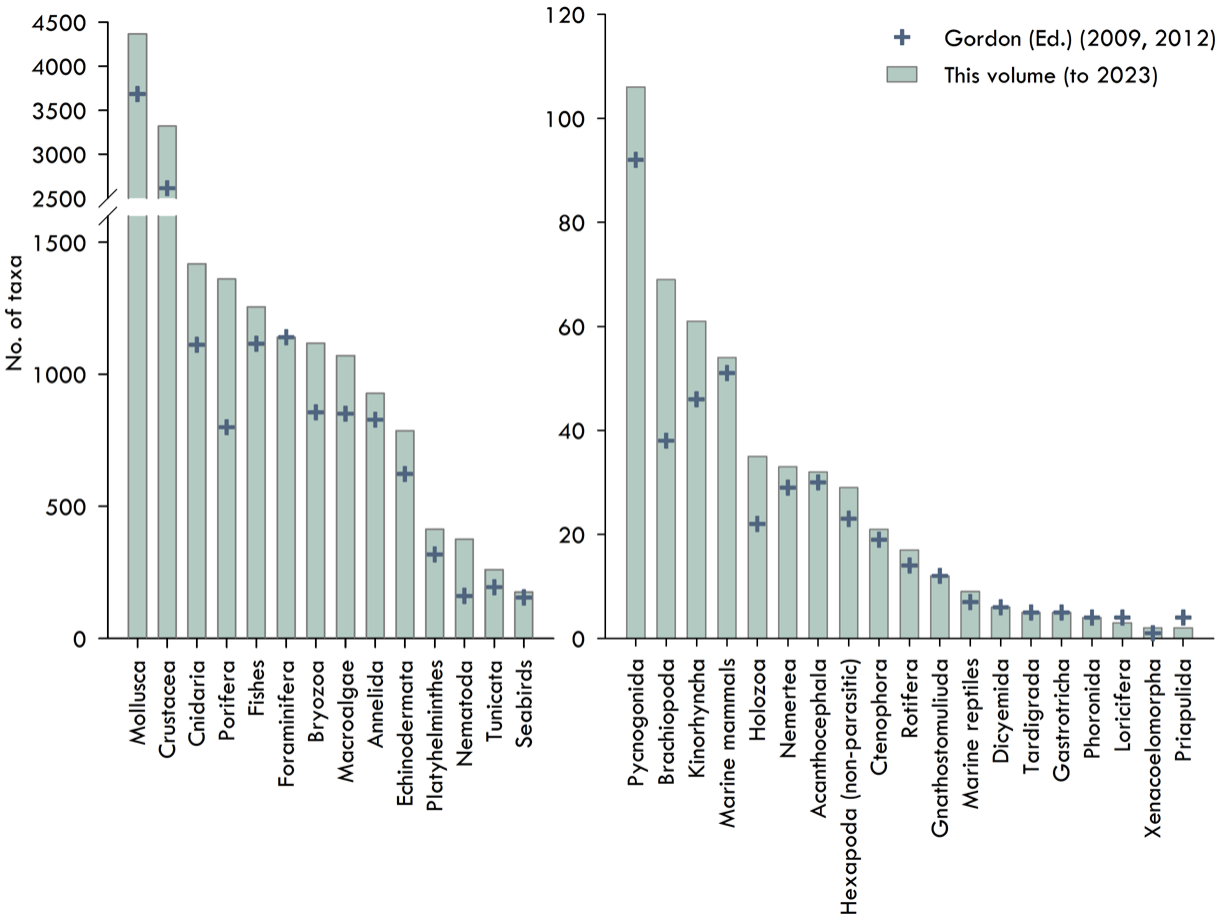

Figure 3. Changes in the total number of extant taxa between the New Zealand Inventory of Biodiversity (Gordon (Ed.) 2009, 2010, 2012) and this volume.

Table 1. Taxonomic groups not reviewed in this volume. The taxon groups listed in this table were not updated either because they were beyond the general scope of this volume, or no new data were available at the time of compilation, or no one was available to provide an update.

Taxon group	Comment
Kingdom Animalia, Placozoa (placozoans, trichoplaxes) (Gordon 2009a)	There are presently only two described marine Placozoa species known, *Trichoplax adhaerens* Schulze, 1883, and *Polyplacotoma mediterranea* Osigus & Schierwater, 2019. Placozoa have not yet been found in New Zealand waters, but they almost certainly occur here (Gordon 2009a).
Kingdom Animalia, Cycliophora (cycliophorans, pandoras) (Gordon 2009b)	None of these lobster parasites are formally recorded as present in New Zealand, although Cycliophora are considered likely to be found in the Pacific (Gordon 2009b).
Kingdom Animalia, Kamptozoa (nodding animals, entoprocts, goblet worms) (Gordon 2009c)	No new Kamptozoa taxa have been added to this group since the previous update of Gordon (2009c).
Kingdom Animalia, Orthonectida (orthonectids) (Hochberg & Kruse 2009)	These worm-like parasites are only known from one new endemic species in New Zealand, *Rhopalura* n. sp. Hochberg & Kruse, 2009, a parasite in the bryozoan *Hippomenella vellicata* (Hochberg & Kruse 2009). We are not aware of any species formally described for New Zealand.
Kingdom Animalia, Hemichordata (acorn worms, pterobranchs, graptolites) (Gordon *et al.* 2009)	Recent genetic analyses of New Zealand *Rhabdopleura* specimens indicate undescribed species variants (Gordon *et al.* 2023). No further work has been carried out since Gordon *et al.* (2009) on fossil taxa within this group.
Kingdom Animalia, Chaetognatha (arrow worms) (Bradford-Grieve & Casanova 2010)	Fourteen described Chaetognatha species were listed from the New Zealand region in Bradford-Grieve & Casanova (2010). There is no taxonomist currently working on this group in New Zealand.
Kingdom Animalia, Arthropoda, Trilobitomorpha (trilobites) (Wright & Cooper 2010)	Eighty species-level Trilobitomorpha taxa were listed in the Wright & Cooper (2010). No further assessment of this group has been carried out in this volume.
Kingdom Animalia, Nematomorpha (horsehair worms, gordian worms) (Poinar 2010)	Only a single marine Nematomorpha species was listed from New Zealand in Poinar (2010), *Nectonema zealandica* Poinar & Brockerhoff, 2001. Nothing further has been described for this region.
Kingdom Animalia, ichnofossils (trace fossils) (Gregory 2010)	More than 100 ichnofossils (trace fossils) from New Zealand strata were listed in Gregory (2010), a number of these being terrestrial. No further assessment of this group has been carried out in this volume.
Kingdom Bacteria (Young *et al.* 2012)	Thirty-nine cultured bacterial genera were listed in Young *et al.* (2012). Bevan Weir, Landcare Research, New Zealand (pers. comm.) advised of three new cultured marine bacteria records since Young *et al.* (2012): an unidentified species of *Yonghaparkia* Yoon *et al.* 2006 (barcode ICMP 22294) (family Microbacteriaceae), isolated from a seaweed in a pond on Whatipu Beach, Auckland, in 2017; and two new species typified from New Zealand: *Salinibacter grassmerensis* Viver *et al.* 2023 (family Salinibacteraceae), described from Kaikoura in 2023 (barcode ICMP 24464); and *Tannockella kyphosi* Pardesi *et al.* 2022 (family Erysipelotrichaceae) isolated from the hindgut of the marine herbivorous fish *Kyphosus sydneyanus* in the Hauraki Gulf (barcode NZRM 4757).
Kingdom Bacteria, Cyanobacteria (blue-green bacteria, blue-green algae) (Broady & Merican 2012)	Forty marine species of Cyanobacteria were listed in Broady & Merican (2012). No further assessment of this group has been carried out in this volume.
Kingdom Protozoa, Euglenozoa (euglenoids, bodonids, trypanosomes) (Allison & Broady 2012)	Seventeen marine species of Euglenoidea and Kinetoplastea were listed in Allison & Broady (2012). No further assessment of this group has been carried out in this volume.
Kingdom Protozoa, Loukozoa (jakobid and malawimonad excavate flagellates) (Gordon 2012a)	Loukozoa has not yet been found in the New Zealand marine environment; Gordon (2012a) considers it likely to be present although it remains undetected.
Kingdom Protozoa, Amoebozoa (amoebas, pelobionts, slime moulds, and kin) (Meisterfeld *et al.* 2012)	Three Amoebozoa species were listed from the New Zealand marine environment in Meisterfeld *et al.* (2012). No further assessment of this group has been carried out in this volume.
Kingdom Protozoa, Apusozoa (thecomonad, ancyromonad, diphylleid zooflagellates) (Gordon 2012b)	Only a single marine Apusozoa species was listed from New Zealand in Gordon (2012b): *Collodictyon sphaericum* Norris, 1964. Nothing further has since been described for this region.
Kingdom Chromista, Oomycota (water moulds, downy mildews) (Beever *et al.* 2012c)	Four marine species of phylum Oomycota were listed in Beever *et al.* (2012c): *Myzocytium proliferum* Schenk 1858; *Sirolpidium bryopsidis* (de Bruyne) H.E. Petersen 1905; *Halophytophthora* sp.; and *Haliphthoros* sp. Vishniac 1958. Salt-tolerant *Phytophthora* were first reported by Maxwell (1968); this record was correctly interpreted by Beever *et al.* (2012c) as *Halophytophthora* (established in 1990), but there had been no confirmed specimens. Bevan Weir, Landcare Research, New Zealand (pers. comm.) now confirms the presence of at least three, possibly new species of *Halophytophthora*, in a single sampling site in Waiwera Estuary, Auckland (Weir, unpubl, data, 11 August 2019).
Kingdom Chromista, Bigyra (opalinids, slime nets, thraustochytrids, bicosoecids) (Gordon *et al.* 2012a)	Nine marine species of Bigyra were listed in Gordon *et al.* (2012a). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Myzozoa (dinoflagellates, perkinsids, ellobiopsids, sporozoans) (Chang *et al.* 2012)	Two hundred and forty-nine extant marine Myzozoa species were listed in Chang *et al.* (2012), and 468 fossils (although it is not noted if these are all marine). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Ciliophora (ciliates) (Foissner *et al.* 2012)	Seventy-eight marine/brackish Ciliophora species were listed in Foissner *et al.* (2012). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Cercozoa (cercomonads, filose testate amoebae, phaeodaria, plasmodiophoras, *Gromia*, haplosporidians, and kin) (Gordon *et al.* 2012b)	Twenty marine species and three fossil Cercozoa species were listed in Gordon *et al.* (2012b). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Radiozoa (radiolaria) (Hollis *et al.* 2012)	One hundred and eighty-two marine Radiozoa species were listed in Hollis *et al.* (2012), and 947 fossil species (although it is not noted if these are all marine). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Cryptophyta (cryptomonads, katablepharids) (Chang & Broady 2012)	Ten marine Cryptophyta species were listed in Chang & Broady (2012). No further assessment of this group has been carried out in this volume.
Kingdom Chromista, Haptophyta (haptophytes) (Rhodes *et al.* 2012)	Ninety marine Haptophyta species and 30 fossil species were listed in Rhodes *et al.* (2012). No further assessment of this group has been carried out in this volume; however, we refer the reader to Chang (2019) for a catalogue and description of the coccolithophores in New Zealand waters.
Kingdom Chromista, Heliozoa (sun protists) (Gordon 2012c)	Two marine Heliozoa species were listed in Gordon (2012c). No further assessment of this group has been carried out in this volume.

(*continued opposite*)

Table 1. (*continued*)

Taxon group	Comment
Kingdom Fungi, Chytridiomycota (chytrids) (Beever et al. 2012a)	Six marine Chytridiomycota species were listed in Beever et al. (2012a). No further assessment of this group has been carried out in this volume.
Kingdom Fungi, Microsporidia (microsporidian fungi) (Malone & Charleston 2012)	Three marine Microsporidia species were listed in Malone & Charleston (2012). No further assessment of this group has been carried out in this volume.
Kingdom Fungi, Ascomycota (yeasts, sac fungi, truffles) (Beever *et al.* 2012b)	Seventy-seven marine Ascomycota species were listed in Beever *et al.* (2012b). No further assessment of this group has been carried out in this volume.
Kingdom Fungi, Basidiomycota (mushrooms, rusts, smuts) (Buchanan *et al.* 2012)	Three marine species of Agaricomycotina were listed in Buchanan *et al.* (2012). Jerry Cooper, Landcare Research, New Zealand (pers. comm.) has advised of two new fungi records from seaweed: *Corollospora marina* (Haythorn & E.B.G. Jones) E.B.G. Jones, K.L. Pang & Abdel-Wahab 2016; and *Steromyces cruciatus* Moreau & F. Moreau ex Hennebert 1962. Cooper (pers. comm., also advised of a new record for New Zealand in *Corollospora angusta* Nakagiri & Tokura, 1987, identified from beach driftwood/seaweed.

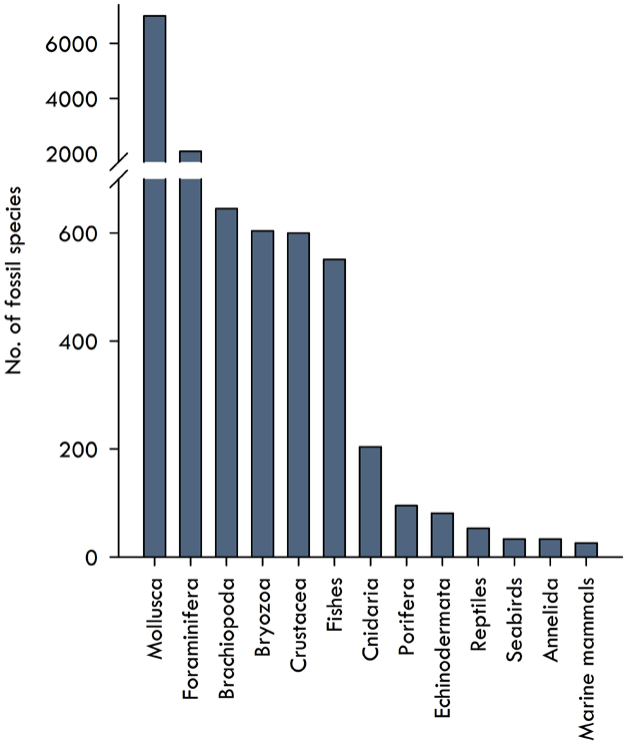

Figure 4. Total number of known fossil marine species for taxon groups in this volume. A single Phoronida fossil species is excluded from the graph due to scale.

Figure 5 presents the proportion of described species that are endemic by taxon group. These proportions are for each taxon group as a whole; however, in some cases these overall percentages do not necessarily reflect the full story. For example, while the average endemicity of New Zealand Crustacea is currently 37%, this varies depending on the group, ranging from <10% for pelagic euphausiid shrimps and copepods, to 93% for small epibenthic peracarid Cumacea (comma shrimps).

Despite global initiatives that recognise the importance of biodiversity, the erosion of funding for taxonomic research and the concomitant loss in capacity and capability has been identified as a global issue. In the New Zealand context, it is starkly illustrated in some groups, e.g., the number of professional foraminiferal research scientists in New Zealand over the past 40 years has declined from 12 to one. The authors of the Echinodermata chapter note that while our knowledge of echinoderm diversity in New Zealand waters has advanced over the past two decades, with a more than 24% increase in the number of described species and an almost 50% increase in the number of known, yet undescribed, taxa, "*an investment in taxonomic expertise is necessary to continue momentum and formally document the true diversity of Echinodermata in the region*". New Zealand has a high proportion of endemic species as a consequence of our geological history and isolation. We have national and global responsibilities to document and protect the biota of our region.

While significant progress has been made in our understanding of aspects of the New Zealand marine biota, there are many points of vulnerability in the taxonomic infrastructure. As noted in Nelson *et al.* (2015), funding for taxonomic research in New Zealand is not obtaining the value and opportunities from natural history collections that could be enabled through a nationally coordinated and accessible asset. Despite the recommendations of both Nelson *et al.* (2015) and the Australasian Decadal Plan (Taxonomy Decadal Plan Working Group 2018), there is no coordinated approach to connecting the collections from museums, CRIs, and universities. Some collections have been shown to be highly vulnerable to local or political changes and their long-term care has been placed in doubt. The inefficiencies of the current funding system are of considerable concern, and do not make sense in the context of the global workforce shortages in taxonomic disciplines. The constrained funding for specialists in taxonomy and collection management mean that trained staff are not funded to work to capacity. This situation does not enable the best use of taxonomists and collections and constrains accessibility of data for end-users.

We are living through an unprecedented global period caused by rapidly accelerating human impacts on the planet resulting in both climate change and biodiversity loss. Many species are becoming extinct before they have been documented: every extinction is a loss for society, the environment, and our future. As noted by Luypaert *et al.* (2018) "*incomplete knowledge of marine species diversity has serious implications for marine conservation… without knowing how many species there are, there is no way to know whether we are effectively conserving marine diversity in different regions and marine groups*". The need for a sound understanding of biodiversity, based on taxonomy and natural history collections has never been greater.

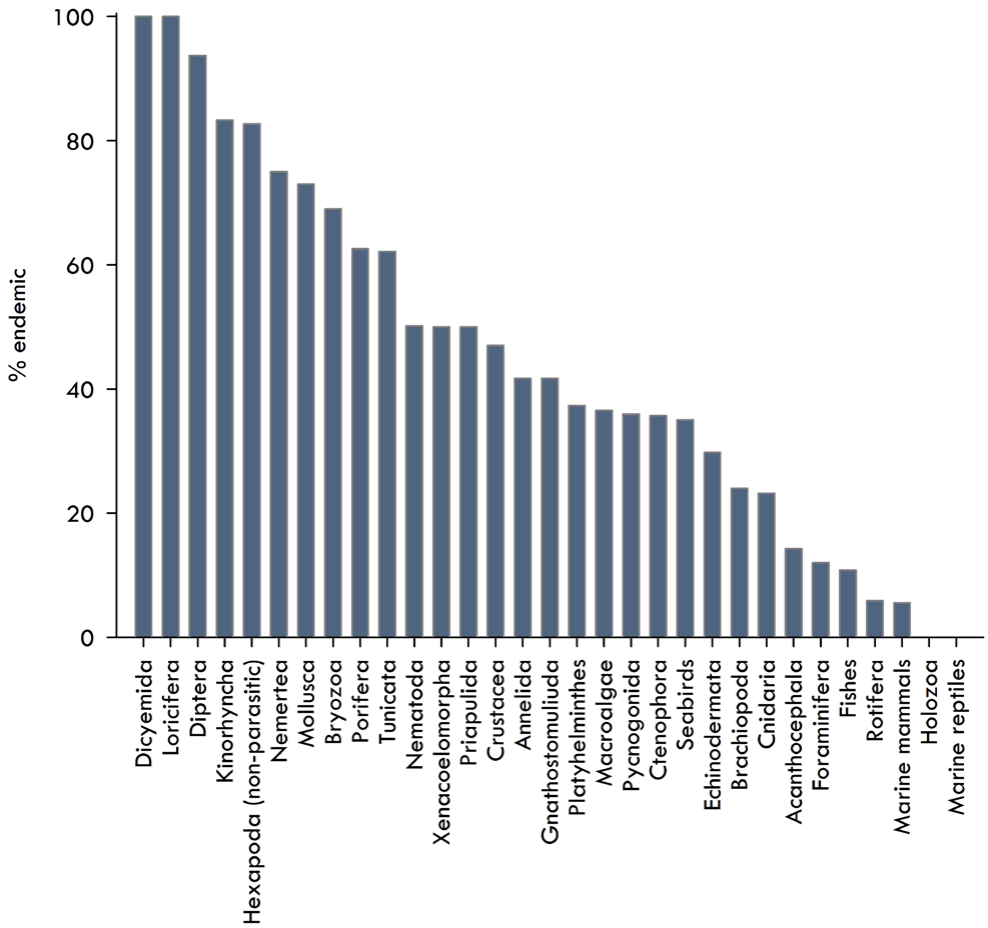

Figure 5. Percentage of described extant species that are endemic to Aotearoa New Zealand.

Methods

Sadie Mills

Geographic scope. The area of study includes the New Zealand Exclusive Economic Zone (EEZ) and the wider New Zealand region encompassing the outer limits of the Extended Continental Shelf (ECS) and surrounding International Waters, as defined by Roberts *et al.* (Eds) (2015), i.e., occurring between 25° S and 56° 30' S, and 158° E and 170° W (Fig. 1). This area includes the seamount regions in the Lord Howe Rise (Australian EEZ and International Waters), the Australian EEZ surrounding Macquarie Island, and the Louisville Seamount Chain (International Waters). Collection localities in the New Zealand EEZ include the estuarine, coastal, and continental shelf areas of mainland New Zealand and its offshore islands, the Kermadec and Colville Ridges, the Kermadec Trench, the Cavalli Seamount region, Chatham Rise, Challenger Plateau, Campbell Plateau and south to the Macquarie Ridge.

Collections. The specimens that form the basis of the checklists in each chapter are either described taxa, or taxonomically indeterminate taxa called operational taxonomic units (OTU), in national, international, and personal collections, and some may have been based upon images only, from Remote Operated Vehicles (ROV) or deep-sea imaging systems such as NIWA's DTIS (Deepsea Towed Underwater Imaging System). The majority of biodiscovery work represented in the following chapters is due to the work of taxonomists identifying specimens and describing new species from both existing historical collections and from new biological collections made by sampling programmes conducted since 2000.

Examples of significant sampling programmes conducted on NIWA's RV *Tangaroa* and RV *Kaharoa* in the period from 2000 to 2020 are: the NORFANZ Biodiversity Survey in 2003, which collected a large number of specimens from Norfolk Ridge and Lord Howe Rise (TAN0308, Clark & Roberts 2008); Oceans Survey 20/20, including the first use of a fine-meshed hyperbenthic 'Brenke' sled on surveys on the Chatham Rise and Challenger Plateau (voyages TAN0705 and TAN0707, Bowden 2011); HADES-ERC exploration of benthic diagenesis, microbiology and biology in the Kermadec Trench (voyage TAN1711, Glud *et al.* 2017); Biogenic Habitats on the Continental Shelf surveys in 2011 (voyages TAN1105 and TAN1108, Jones *et al.* 2018), and a series of voyages conducted since 2001 under the "Ecology of Seamounts" programme and later the "Vulnerable Deep-Sea Communities" project (KAH0006, KAH0011, TAN0104, TAN0107, KAH0204, TAN205, TAN0306, TAN0307, TAN0413, TAN0604, TAN0614, TAN0803, TAN0905, TAN1004, TAN1206, TAN1213, TAN1311, TAN1503, TAN2009 e.g., Clark *et al.* 2019, 2022), capturing both specimens and seafloor images on DTIS.

Scientific observers funded by the Ministry for Primary Industries (MPI, Fisheries New Zealand), and scientific staff on NIWA Fisheries Research Trawl Surveys funded by Fisheries New Zealand also provide a great resource by collecting unusual specimens from fishing bycatch and returning them for further study. Additionally, the investigation of the biodiversity of the coastal and offshore waters of the Kermadec Islands that took place on the RV *Braveheart* during the Kermadec Biodiscovery Expedition 2011 (Trnski & de Lange 2015), and on the RV *Tangaroa* on voyage TAN1612 (Clark *et al*. 2017), have collected specimens that increase our knowledge of the shallow subtropical waters of the northern New Zealand region.

International vessels visiting the New Zealand region have brought ROV and Human-Occupied Vehicle (HOV) submersible technology, enabling the capture of high-definition imagery and selection of intact and rare specimens, for example: the New Zealand American Submarine Ring of Fire 2005 Kermadec Arc Submarine Volcanoes expeditions on RV *Ka'imikai-a-Kanaloa*, using ROV *Pisces V* (voyages KOK05-05 and KOK05-06, see Merle *et al*. 2005); German RV *Sonne* cruises exploring cold seeps on the Hikurangi Margin (SO-191, Bialas *et al*. 2007), hydrothermal vents in the Kermadec region using Canadian ROV *ROPOS* (SO192-2, Schwarz-Schampera *et al*. 2010) and deepsea habitats throughout the whole New Zealand region using the GEOMAR ROV *KIEL 6000* (SO254, Schupp *et al*. 2017); HADES Kermadec Trench Expedition 2014 on the RV *Thomas G. Thompson* with HROV *Nereus* (https://www.web.whoi.edu/hades/kermadec-2014/); the joint JAMSTEC-NIWA expeditions to the Kermadec-Tonga Trench (YK13-10, JAMSTEC 2013) and Louisville and Kermadec Ridges (YK13-11, JAMSTEC *et al*. 2013) on the Japanese R/V *Yokosuka* with submersible HOV *Shinkai 6500*. Other field campaigns relevant to specific taxa have also been mentioned in individual chapters.

Collection data sources. Authors were provided with data extracts from several national collections to assist in the verification of type and voucher material, and to assist the population of checklists with regional occurrence and depth data. These data extracts were provided from the NIWA Invertebrate Collection (NIC) *niwainvert* database (December 2019 dataset, 105,793 records), NIWA Macroalgal Collection *niwaalgae* database (December 2022 dataset; 15,559 records), the NIWA Marine Invasive Taxonomic Service Collection (MITS) *niwabiosec* database (October 2019 dataset, 2,332 MPI public portal records from New Zealand ports and harbours), Museum of New Zealand Te Papa Tongarewa (NMNZ) invertebrate (2015 dataset, 88,747 records), fishes (May 2020 dataset; 44,573 records) and algal data (September 2021 dataset; 17,058 records), Auckland War Memorial Museum Tāmaki Paenga Hira (AIM) invertebrate (August 2019 data extract, 23,581 records), fishes and algal collections (July 2019 dataset; 18,707 records). Fossil records were provided from publications on material within, or associated with, the GNS Science National Paleontological Collection and the University of Otago Geology Museum.

Authors contributed data from their personal and collaborators' collections and sought out data from other regional and international collections, as necessary for their groups. Authors also reviewed taxonomic literature published after the date of their earlier reviews in Gordon (Ed.) (2009, 2010, 2012) and were able to add records of new species publications, or taxonomic classification changes, right up to early December 2023. Species distributions were assessed by authors by mapping the collection records mentioned above, or by accessing species data from the Ocean Biodiversity Information System (OBIS, https://www.obis.org/), or the citizen science platform iNaturalistNZ–Mātaki Taiao (https://www.inaturalist.nz/), or by referring to the National Marine High-Risk Site Surveillance (NMHRSS) programme database funded by MPI (Biosecurity New Zealand) (February 2020 dataset, 223,135 records).

Note that there are still large proportions of historical specimens in collections that are not registered in collections databases and mostly not yet identified. For example, although increasing effort is made to address the historical backlog, approximately 50% of the NIC is still unregistered, with some taxon groups better represented in the database than others. The NIC Cnidaria and Echinodermata collections are almost completely catalogued, while Ascidiacea and Mollusca collections are mostly unregistered, and the Bryozoa and Annelida collections are ~40% catalogued (estimated July 2023). NIWA Algal collections have only been databased up to the end of 2022. Work is in progress to curate voucher specimens from national monitoring of soft sediment infauna from coastal habitats such as harbours and estuaries, along with macrofaunal specimens and meiofaunal slides from deepsea sediments, as these are chronically under-represented in New Zealand collections.

Organisation of the checklists and tables. The checklists and tables at the end of each chapter represent our current knowledge of the biodiversity of extant and fossil marine biota of the New Zealand region. They are usually arranged according to the currently accepted systematics and classificatory scheme employed by the World Register of Marine Species (WoRMS) (http://www.marinespecies.org/), as unique to each taxon. The checklists and tables contain: (1) All original taxonomic names and authorities of extant and fossil marine biota cited in Gordon (Ed.) (2009, 2010, 2012) considered to be valid in WoRMS, except for those that are no longer considered valid in the New Zealand region because they were added in error (as a historical mistake), or because their global taxonomic and distribution status has been updated, and are thus expunged from the New Zealand record; (2) All extant and fossil biota cited in

Gordon (Ed.) (2009, 2010, 2012) that have been revised taxonomically and are now considered to be valid in WoRMS; (3) All new extant or fossil marine biota that have been described or determined since Gordon (Ed.) (2009, 2010, 2012); (4) Extant and fossil biota cited in Gordon (Ed.) (2009, 2010, 2012) that have been revised or relegated in synonymy according to WoRMS.

All taxonomically indeterminate taxa or operational taxonomic units (OTU) cited in Gordon (Ed.) (2009, 2010, 2012) (taxa that are legitimately and effectively published but not generally accepted as distinct, or entities that are yet to be furnished with a formal name) have been revisited and their nomenclature updated according to the NIWA Biodiversity Memoir style guide for authors (https://www.niwa.co.nz/oceans/niwa-biodiversity-memoirs/about#author-info) or deleted as unrecognisable. Any species names in the checklist that include qualifiers 'cf.', 'aff.', 'sp.', 'sp. nov.' or other combination, even if published, are regarded as taxonomically indeterminate and are thus OTUs. The vast majority of OTUs now contain an identifiable accession number or information about the collection holding institution that voucher specimens can be accessed from, and if not, the name of the determining authority or locality, so that the species can be traced where possible. Any new OTUs, whether in personal, national, or international collections, have also been added.

Endemic taxa are indicated in the checklists by 'E' for those found within the New Zealand EEZ, or 'E2' for taxa endemic to the wider New Zealand region encompassing the New Zealand EEZ and surrounding International Waters, as defined by Roberts *et al.* (Eds) (2015), i.e., occurring between 25° S and 56° 30' S, and 158° E and 170° W (Fig. 1). Where no clear distinction has been made between levels of endemicity, 'E' is used to denote endemic taxa. Non-indigenous species are indicated by 'NI', as defined in Table 1 of Seaward *et al.* (2015). All other taxa are considered indigenous by default, i.e., naturally occurring around New Zealand and elsewhere.

Fossil species are followed by stratigraphic names using the standard nomenclature within the New Zealand Geological Timescale (NZGTS), updated in Raine *et al.* (2015) and illustrated in Figure 6.

The taxonomic authorities and dates for the taxa listed in the text and checklists are not included in the references section of chapters where they are publicly available within online databases such as WoRMS but may be included in some chapters for taxa that do not have these readily available. Note that if there are more than two taxonomic authorities, the taxonomic authority in the checklist is abbreviated to 'first author *et al.*'

Spreadsheets of supplementary data are available separately, along with PDFs of each chapter, at https://www.niwa.co.nz/oceans/niwabiodiversity-memoirs and will contain all taxon and associated data. The supplementary dataset will inform any future updates to the New Zealand Threat Classification System (NZTCS, see Townsend *et al.* 2008; Rolfe *et al.* 2021; Michel 2021), and the Department of Conservation reviews of marine invertebrates (Funnell *et al.* 2023), birds (Robertson *et al.* 2021) reptiles (Hitchmough *et al.* 2021), marine mammals (Baker *et al.* 2019), and macroalgae (Nelson *et al.* 2019a). A regional WoRMS portal, the New Zealand Register of Marine Species, is being developed using the checklist data from each chapter.

Summary of species diversity. The first table in each chapter summarises species diversity numbers for the phylum under consideration. The category "Estimated unknown species" in Gordon (Ed.) (2009, 2010, 2012) has proven almost impossible to estimate for most taxa in this volume. While that statistic provided a useful indication of how well the New Zealand marine biota was known at the time and underpinned the continued need for exploration of new and under-sampled locations, and the retention and identification of unidentified/unsorted collections, it is now perhaps more accurately reflected in the category "Undescribed extant species (OTU)".

The category "Undescribed extant species (OTU)" is used to classify undescribed species or groups of closely related individuals. An OTU follows the International Code of Zoological Nomenclature (4th edition 1999) operational nomenclature generally, and the format adopted in the New Zealand Threat Classification System (Townsend *et al.* 2008). This naming convention is used when taxa are taxonomically determinate (legitimately and effectively published or unpublished, and generally accepted by relevant experts as distinct), or taxonomically indeterminate (legitimately and effectively published or unpublished, but not generally accepted as distinct, or entities that are yet to be furnished with a formal name).

Taxonomic groups not included. Of the 73 taxonomic groups reviewed in Gordon (Ed.) (2009, 2010, 2012), no formal reviews were carried out in this volume for 28 groups (Table 1). This is because many are single-celled taxon groups and are thus beyond the general scope of this work (except for Foraminifera and Opisthokonta-Holozoa). For many of these 28 taxon groups, we have endeavoured to check WoRMS for updates; for several groups, there are still no marine species recorded from the New Zealand region in the group, hence there have been no new taxa added to the fauna since last reviewed. Finally, the lack of expertise availabile, both nationally and internationally, was a significant contributing factor in the inability to provide an update for many groups. Minor updates have been provided here for Kingdoms Bacteria, Chromista (Oomycota), and Fungi (Basidiomycota) (B. Weir & J. Cooper, pers. comm.).

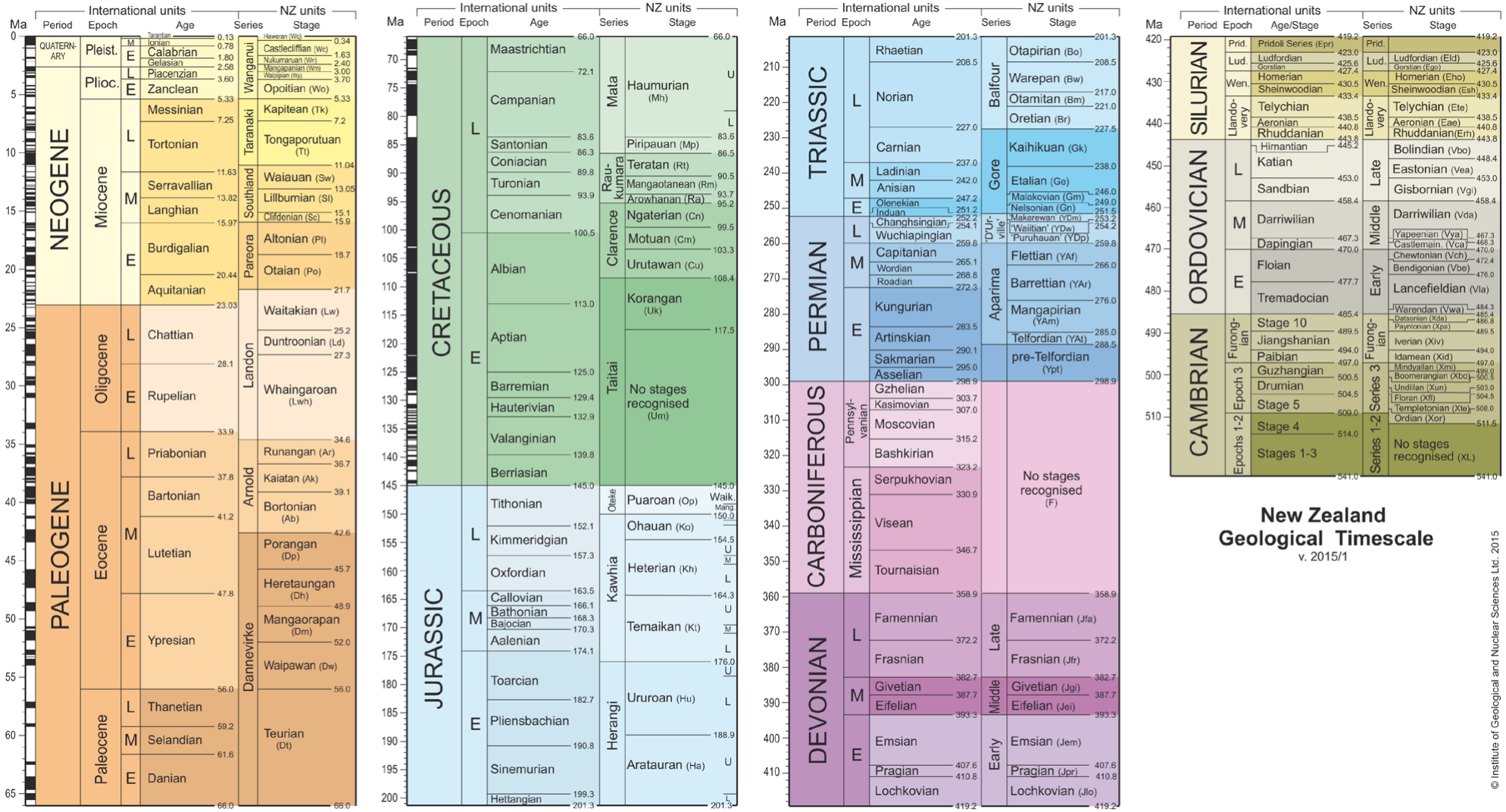

Figure 6. New Zealand Geological Timescale v. 2015/1 (Raine *et al.* 2015, GNS Science Report 2012/39), based on Cooper (Ed.) 2004, GNS Science Monograph 22, with incorporated revised ages from the 2014 International Chonostratigraphic Chart 2014/10 (Cohen *et al.* 2014) and recalibration of New Zealand stage boundaries.

Abbreviations & acronyms

AIM Auckland War Memorial Museum Tāmaki Paenga Hira, Auckland; collections prefixed MA–; herbarium collections prefixed AK–

AMS Australian Museum, Sydney, New South Wales, Australia; catalogued specimen collections prefixed AM–, catalogued brachiopod specimens prefixed C–.

AU University of Auckland, Auckland; accession prefix for catalogued specimens at the University of Auckland School of Environment AU–, catalogued brachiopod specimens prefixed B–.

BSKU Kochi University, Department of Natural Science, Faculty of Science, Kochi, Japan

C1 Cryptogenic species 1

C2 Cryptogenic species 2

CAS California Academy of Sciences, San Francisco, California, USA

CCAMLR Commission for the Conservation of Antarctic Marine Living Resources

CM– Accession prefix for catalogued specimens at the Canterbury Museum, Christchurch

CRI Crown Research Institute (New Zealand)

DH Definitive host of parasitic fauna (see Chapter 8 Platyhelminthes)

DNA Deoxyribonucleic acid

DTIS Deep Towed Imaging System (NIWA)

E Endemic species

E2 Species endemic to the extended New Zealand region

ECS Extended Continental Shelf

EEZ Exclusive Economic Zone

GEOMAR Research Centre for Marine Geosciences, Helmholtz Centre for Ocean Research Kiel, Germany

GNS GNS Science, Te Pū Ao, Wellington (BR– is the accession prefix for the brachiopod specimens; CD– is the accession prefix for the chordate specimens; FP– is the accession prefix for figured foraminifera specimens; GS– is the accession prefix for catalogued lots; TF– is the accession prefix for type foraminifera specimens). All are held within the National Paleontological Collection, GNS Science, Lower Hutt.

HADES Hadal Ecosystems Studies acronym used for several research programmes conducted in hadal trenches worldwide.

HADES-ERC Hadal Ecosystems Studies funded by the European Research Council

HOV Human-Occupied Vehicle (submersibles)

HROV Hybrid Remote Operated Vehicle

ICBM Institut für Chemie und Biologie des Meeres der Carl von Ossietzky Universität Oldenburg, Germany

IH Intermediate host of parasitic taxa (see Chapter 8 Platyhelminthes)

IPCC Intergovernmental Panel on Climate Change

IV– Accession prefix for invertebrate specimens held at Otago Museum

LACM Natural History Museum of Los Angeles County, Los Angeles, California, USA

MAFBNZ Ministry of Agriculture and Forestry Biosecurity New Zealand

MCZ Museum of Comparative Zoology, Harvard University, Ichthyology Department, Cambridge, Massachusetts, USA

MITS Marine Invasives Taxonomic Service

MNHN Muséum National d'Histoire naturelle, Systématique et Évolution, Laboratoire d'Ichthyologie Générale et Appliquée, Paris, France

MV Museums Victoria, Melbourne, Australia

MoV– Museums Victoria undescribed taxon reference number

NHMUK Natural History Museum (formerly British Museum of Natural History), London, United Kingdom (accession prefix previously BMNH, now NHMUK)

N Native species

NI Non-indigenous species

NIC NIWA Invertebrate Collection, NIWA, Wellington

NIWA National Institute of Water and Atmospheric Research (New Zealand)

NIWA– Accession prefix for catalogued specimens in the NIWA Invertebrate Collection (NIC), Wellington

NIWA MITS Marine Invasive Taxonomic Service collection funded by MPI Biosecurity

	held within the NIWA Invertebrate Collection (NIC), Wellington
NMMBP	Pisces Collection, National Museum of Marine Biology and Aquarium, Pingtung, Taiwan
NMNZ	Museum of New Zealand Te Papa Tongarewa, Wellington. Registration numbers of specimens held at the NMNZ are prefixed: CO. (Cnidaria); CR. (Crustacea); M. (Mollusca); P. (fish specimens); POR. (Porifera). TMP. numbers refer to records held by NMNZ.
NSMT	National Museum of Nature and Science, Zoology Department, Division of Fishes, Tsukuba, Japan
NZGTS	New Zealand Geological Timescale
NZOI	New Zealand Oceanographic Institute (now NIWA)
OBIS	Ocean Biodiversity Information System (https://www.obis.org)
OTU	Operational Taxonomic Unit. An operational definition used to classify undescribed species or groups of closely related individuals (see first table in most chapters).
OU–	Accession prefix for catalogued specimens at the Geology Museum, Department of Geology, The University of Otago, Dunedin (collections under collector's field number, specimens in J.D. Campbell's catalogue prefixed C).
QM	Queensland Museum, Brisbane, Queensland, Australia
ROV	Remote Operated Vehicle
RV	Research Vessel
SMF	Senckenberg Forschungsinstitut und Naturmuseum, Abteilung Marine Zoologie, Sektion Ichthyologie, Frankfurt am Main, Hessen, Germany
SMNS	Staatliches Museum für Naturkunde in Stuttgart, Stuttgart, Baden-Württemberg, Germany
SPRFMO	South Pacific Regional Fisheries Management Organisation
SSU rDNA	Small subunit ribosomal DNA
UoA	University of Auckland
USNM	Smithsonian Institution National Museum of Natural History, Department of Vertebrate Zoology, Division of Fishes, Washington D.C., USA
V–	Accession prefix for catalogued speciments at The Victoria University of Wellington, New Zealand
VUW	Victoria University of Wellington
WAM	Western Australian Museum, Perth, Western Australia, Australia
WELT	Herbarium collection at the Museum of New Zealand Te Papa Tongarewa, Wellington
WoRMS	World Register of Marine Species (http://www.marinespecies.org/)
WPD	World Porifera Database (http://www.marinespecies.org/porifera/)
ZMH	Johann Heinrich von Thünen-Institut (vTI), Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei, Hamburg, Germany (also previously FBH and ISH)
ZMMGU	Zoological Museum, Biological Faculty, M.V. Lomonosov Moscow State University, Moscow, Russia
ZMUC	Københavns Universitet, Zoologisk Museum, Vertebrater, Fiskesamlingen, Copenhagen, Denmark

Definitions

Cryptogenic 1 species	Species previously recorded from New Zealand whose identity as either native or non-indigenous is ambiguous. This uncertainty may be because the species was spread by humans prior to scientific investigation, such that it is no longer possible to determine their original native distribution.
Cryptogenic 2 species	Species that have been recently discovered, for which, there is insufficient systematic or biogeographic information to determine whether New Zealand lies within their native range. This category includes previously undescribed species that are new to New Zealand or science.
Endemic	Biota native to, and restricted to, a particular area or region of the New Zealand biogeographical region; not found naturally anywhere else in the world.
Extant	The preferred term used to mean a species that is still *living*, in clear opposition to the term *extinct* (see *living*).
Extended Continental Shelf	Ranging from the northern Norfolk Ridge at 26.4° N (north of Norfolk Island) to the Hjort Seamount and southern end of Hjort Trench at 59° S,

	and eastwards to a remote seamount in the Louisville Seamount chain at 169° W. The Extended Continental Shelf is a well-defined legal boundary (see https://www.mfat.govt.nz/en/environment/oceans-and-fisheries/our-maritime-zones-and-boundaries/).
Extended New Zealand region	Occurring between 25° S and 56° 30' S, and 158° E and 170° W, as defined by Roberts *et al.* (Eds) (2015).
Extinct	Term used to mean a species that is no longer living.
Living	Sometimes used as a synonym for *extant* (see *extant*).
Louisville Ridge	Outside the EEZ boundary but within Endemic 2 (Roberts *et al.* (Eds) 2015: fig. 3).
Native species	Biota naturally occurring within the New Zealand biogeographical region and may occur naturally elsewhere.
New Zealand Exclusive Economic Zone	The exclusive economic zone is an area of sea beyond and adjacent to the territorial sea. The outer limit of the exclusive economic zone cannot exceed 200 nautical miles from the territorial sea baseline. Where the New Zealand EEZ abuts the maritime zone of another nation, a median line between the nations is agreed.
Non-indigenous species	Biota naturally occurring outside the New Zealand biogeographical region, which are known or suspected to have been introduced as a result of human-mediated transport, supported by nine criteria (Chapman & Carlton 1994; Seaward *et al.* 2015).
Northern Zealandia	The northern half of Zealandia along the Norfolk Ridge or Lord Howe Rise toward New Caledonia and the Chesterfield Plateau.
Operational Taxonomic Unit (OTU)	Operational nomenclature follows the International Code of Zoological Nomenclature (4th edition 1999) generally, and the format adopted in the New Zealand Threat Classification System (Townsend *et al.* 2008). OTUs are used when taxa are taxonomically determinate (legitimately and effectively published or unpublished, and generally accepted by relevant experts as distinct), or taxonomically indeterminate (legitimately and effectively published or unpublished, but not generally accepted as distinct, or entities that are yet to be furnished with a formal name).
Recent	An informal term used to mean the Holocene Epoch, now considered ambiguous and likely to be confusing. The terms Holocene or *extant* are more informative and are preferred.
Southern Lord Howe Rise	Between or outside of Australian and NZ EEZ boundaries to the northwest of the Challenger Plateau but well within Endemic 2 (Roberts *et al.* (Eds) 2015; fig. 3).
Southern Norfolk Ridge	Between or just outside Australian and NZ EEZ boundaries but well within Endemic 2 (Roberts *et al.* (Eds) 2015: fig. 3).
Territorial Sea	The Territorial Sea is an area of water not exceeding 12 nautical miles in width that is measured seaward from the territorial sea baseline (which, in most cases, is the low water mark).
Zealandia	The mostly submerged continent of New Zealand and New Caledonia.
Zealandian	Pertaining to the geological continent of Zealandia, ranging from 17.40° S (northern Loyalty Ridge) to 56.00° S (southern slope of Campbell Plateau).

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Voucher specimens referenced in checklists were collected from a wide variety of expeditions and field campaigns and we are indebted to the numerous collaborators and funders that made this possible. The following list is not exhaustive but attempts to capture some of the research programmes that contributed valuable specimens to this work: "Seamounts: their importance to fisheries and marine ecosystems", undertaken by NIWA and funded by the New Zealand Foundation for Research, Science and Technology (FRST) with additional funding from the New Zealand Ministry of Fisheries (MFish); RENEWZ I (TAN0616) voyage, were components of the project "Exploration of Chemosynthetic Habitats of the New Zealand Region", funded by NOAA Ocean Exploration and NIWA, with co-funding from Woods Hole Oceanographic Institution (WHOI), Scripps Institution of Oceanography, and the University of Hawai'i; "Ocean Survey 20/20 Chatham/Challenger Biodiversity and Seabed Habitat Project", jointly funded by MFish, Land Information New Zealand (LINZ), NIWA, and Department of Conservation (DOC); the interdisciplinary New Zealand-Australian "MacRidge 2" research voyage (TAN0803), the biological component of which was part of NIWA's research project "Seamounts: their importance to fisheries and marine ecosystems" funded by FRST, and CSIRO's Division of Marine and Atmospheric Research project "Biodiversity Voyages of Discovery" funded by the CSIRO Wealth from Oceans Flagship; "Impact of resource use on vulnerable deep-sea communities", funded by the Ministry of Business, Innovation & Employment (MBIE); "Kermadec Arc Minerals (KARMA) voyage (TAN1007)", funded by MBIE, in collaboration with Auckland University, GNS Science (New Zealand), and WHOI; "Ocean Survey 20/20 Mapping the Mineral Resources of the Kermadec Arc Project" (voyage TAN1104) funded by LINZ, GNS Science, NIWA, and WHOI; "Biogenic Habitats on the Continental Shelf project (voyages TAN1105 & TAN1108)", funded by MFish, FRST, NIWA and Oceans Survey 20/20 RV *Tangaroa* days funded by LINZ; NIWA trawl surveys funded by Fisheries New Zealand (FNZ); "Nascent Inter-Ridge Volcanic And Neotectonic Activity (NIRVANA, TAN1213) voyage", funded by MPI, in collaboration with Auckland University, GNS Science, and the University of New Hampshire (USA) and with funding from the programme "Impact of resource use on vulnerable deep-sea communities" funded by MBIE; Specimens were collected on the TAN1402 voyage by NIWA as part of the South Pacific Vulnerable Marine Ecosystems Project (C01X1229) funded by MBIE; "Biodiversity of the Kermadec Islands and offshore waters of the Kermadec Ridge – a coastal, marine mammal and deep-sea survey (TAN1612)". Support for the survey to take place came from Marine Funding Advisory Research Group, NIWA, Te Ohu Kai Moana, Ngāti Kuri, and Te Aupouri. The following institutions, University of Auckland, Auckland War Memorial Museum, Department of Conservation, Massey University, NIWA, Te Papa Tongarewa and The Pew Charitable Trusts funded staff to participate in the voyage, with additional budget and gear support from NIWA, Te Papa, Auckland War Memorial Museum, Ministry for the Environment, and The Pew Charitable Trusts; "HADES-ERC-Kermadec Trench project (voyage TAN1711/HEK-1)", primarily funded by a five-year European Research Council Advanced Grant (ERC adG 2014 669947) to the University of Southern Denmark. 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Several underwater images of sponges and benthic ctenophores used in this volume were reproduced

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