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Development of a Tier 1 National Reporting Statistic for New Zealand's Marine Biodiversity

New Zealand Aquatic Environment and Biodiversity Report No. 147

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EXECUTIVE SUMMARY

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In October 2012, the New Zealand Government signed off on a range of new environmental Tier 1 Statistics to be implemented or developed for national reporting. The list included the development of a new marine Tier 1 statistic, "Marine Biodiversity" to report on the wellbeing and knowledge state of marine biodiversity in New Zealand waters. Here, we evaluate the utility and feasibility of developing the variables published by Costello et al. (2010), and recommend marine biodiversity statistics for Tier 1 National reporting on the state of marine biodiversity in New Zealand.

New Zealand has made an international commitment under the Convention on Biological Diversity to halt the current decline in indigenous biodiversity. The New Zealand Biodiversity Strategy also contains an explicit commitment to address the paucity of knowledge of biodiversity, resulting in better, more widely used information. Early in the evaluation of marine biodiversity statistics, it became apparent that there was not sufficient spatial coverage or repeated temporal sampling for increases and declines in species richness to be reported across New Zealand waters. However, reporting on the state of progress was worthy of further exploration, as new species records are documented, and gaps in the spatial coverage of biodiversity information are addressed. As such, we focussed on the process of gathering data, as a way of reporting progress on New Zealand's commitment to generating knowledge of the biodiversity of its marine estate. Tier 1 statistics also aim to provide information that will improve understanding (e.g., by managers and the general public) of the 'phenomenon' itself, in this case, 'What is marine biodiversity?' Variations on the proposed marine biodiversity metrics can fulfil these requirements. For example, a species richness metric allows for presentation of broad scale spatial patterns in marine biodiversity knowledge, and information on taxonomic diversity in the New Zealand EEZ. Reporting on non-indigenous marine species and threatened species can indicate trends in the health of New Zealand's marine biodiversity. Broad-scale monitoring programmes would be required to document national trends in the health or integrity of marine biodiversity at a regional or national scale, and are expected to be incorporated into a separate Ecological Integrity Tier 1 statistic.

We recommend the following components to form the core of a new Marine Biodiversity Statistic:

1. Species richness. Increases in species richness are likely to be reported as taxonomic and spatial knowledge increases over the foreseeable reporting cycles for this statistic. Thus we suggest a focus on:
   - Spatial distribution of the number of records in OBIS and other high quality national databases, per 100 km x 100 km grid cell for the NZ EEZ.
   - Number of species described from the NZ EEZ, reported across broad taxonomic categories.
2. State of knowledge
   - Number of new species identified during reporting period.
   - Changes in spatial coverage of biodiversity information.
3. Endemic species
   - 'Static' proportion of endemic species as a matter of general interest; no reporting of trends in the proportion of endemic species
   - Number of new non-native species recorded.
4. Threatened species
   - Number of threatened species and changes in the threat status across broad taxonomic categories using the full range of threat categories.
   - Changes in the number of species assessed, or classified as data deficient.

1. INTRODUCTION

1.1 Background for Tier 1 Marine Biodiversity Reporting

In October 2012, Government signed off on a range of new Tier 1 Statistics to be implemented or developed under the Natural Resources Sector. The Ministry for Primary Industries agreed to lead the development of a new marine Tier 1 statistic, "Marine Biodiversity" that is intended to report on the wellbeing and knowledge state of marine biodiversity in New Zealand waters. New Zealand has made an international commitment under the Convention on Biological Diversity to halt the current decline in indigenous biodiversity. The New Zealand Biodiversity Strategy also contains an explicit commitment to address the paucity of knowledge of biodiversity, resulting in better, more widely used information. The Ministry for Primary Industries has responsibility to maintain associated and dependent species in addition to sustainable use of fish stocks in New Zealand waters. Primary productivity and marine biodiversity underpin goods and services provided by the marine environment, and form a key area of investigation under the Ministry for Primary Industries Biodiversity Research Programme. Ecosystem integrity (an indicator of the health of biodiversity and ecosystems) is key to the Department of Conservation's 'ecological integrity' strategy to assess the health of species and ecosystems (http://www.doc.govt.nz/about-doc/policies-and-plans/managing-natural-heritage/a-national-system-to-monitor-and-report-on-biodiversity/).

The marine ecosystem is New Zealand's most biodiverse ecosystem, and is a global hotspot for marine biodiversity (Gordon et al. 2010, MacDiarmid 2007, Arnold 2005). New Zealand's EEZ is the fourth largest national EEZ, comprising roughly 4.2 million km^2, spanning 30 degrees of latitude, and covering depths ranging from shallow coastal and estuarine ecosystems to deep trenches approximately 10 km in depth. Over half of the EEZ is deeper than 2000 m, with limited surveys to document biodiversity both in these deeper areas as well as in many shallower subregions (Gordon et al. 2010). New Zealand's marine fauna and flora have a high level of endemism (over 50%), with 6740 of 12 820 described species classified as endemic to New Zealand's waters (Gordon et al. 2010). Rates of endemism are particularly high for some taxonomic groups such as sponges, molluscs, ascidians and bryozoans. A further 4315 species are housed in national collections awaiting formal taxonomic descriptions (Gordon et al. 2010); taxonomic experts conservatively estimate a further 17 220 species are undescribed in the New Zealand EEZ based on proportions already described in other well-known areas of the world (Gordon et al. 2010). Others have estimated much higher numbers of undescribed species, with a total of 65 000 known and undescribed species suggested in one review of New Zealand's marine biodiversity (MacDiarmid 2007). Diversity estimates based on eight intensively studied taxonomic groups suggest that New Zealand species biodiversity is equivalent to the ERMS (European Register of Marine Species) region, which covers an area 5.5 times larger than New Zealand's EEZ (Gordon et al. 2010; Costello et al. 2010).

Previously, researchers have developed models of spatial patterns in biodiversity at national scales for New Zealand. Arnold (2005) reviewed hotspots of species richness across broad taxonomic categories based on a series of expert workshops for a World Wide Fund for Nature – New Zealand report on the marine environment, with a particular focus on vertebrate taxa. A more detailed report summarised patterns of species distribution in the New Zealand EEZ across a broad range of taxa (MacDiarmid 2007). Taxonomic resolution varied, with higher resolution information available for many vertebrate taxa, e.g., for seabirds, information generally included species spatial distributions and seasonal/breeding distributions. For most invertebrate taxa, this report opted to summarise information to family, order or other lower resolution taxonomic groupings, as spatial distributions of abundance were generally not available at the species level for invertebrate taxa. Species distributions were presented as hotspots, and 90 and 100% confidence intervals of spatial distributions. Spatial distribution maps are publicly available on NABIS (www.nabis.govt.nz). A further series of reports 'Mapping the Values of New Zealand's Coastal Waters' included a detailed spatial mapping of environmental measures into coastal cells of roughly 20 km in length; environmental measures included overall and taxon-specific patterns in biodiversity, and distributions of threatened species, non-indigenous species, habitats (including both biogenic habitats and physical habitats as described using the Marine Environments Classification), areas of special biological/ecological significance, areas of protection, and primary productivity (Beaumont et al. 2008, 2009, MacDiarmid et al. 2008).

At an international scale, Costello et al. (2010) provided regional and national comparisons of biodiversity in terms of species numbers (per unit area), knowledge state, and threat status using datasets primarily from the Census of Marine Life (www.coml.org). Information was also presented by taxonomic groupings, and to reflect proportions of endemic and alien species in each of 26 international regions as defined by the Census (Costello et al. 2010).

National indicators of biodiversity and ecosystem health have been investigated in a number of recent studies. Tuck et al. (2013) suggested a suite of ecosystem and environmental indicators that could be used to monitor and analyse the ecosystem changes in deepwater fisheries areas. Pinkerton (2010) summarised key potential indicators to describe pressures on marine environments, the state of ocean ecosystems, and management responses to promote sustainability. Thrush et al. (2011) investigated potential ecological indicators for evaluating trends in ecosystem integrity in New Zealand's marine protected areas for the Department of Conservation, providing a hierarchy of metrics that are being field tested for their suitability. Other national projects (e.g., the Marine Environmental Monitoring Programme (Hewitt et al. 2014)) and collaborative activities across the Natural Resources Sector will improve data management across government organisations to support Tier 1 Statistics.

Here, we investigate the feasibility of utilising the variables published by Costello et al. (2010) to report on the status of marine biodiversity in New Zealand. We investigate four potential metrics: 1) species richness per square km; 2) state of knowledge index; 3) proportion of endemic species; and 4) number of threatened species. Metric suitability was evaluated based on data availability and quality for calculating statistics, likelihood of showing change over reporting periods, and compatibility with international reporting statistics and official Tier 1 National Reporting Statistics protocols and principles. Development of the statistics involved a collaborative and consultative approach, and two workshops were held with Natural Resources Sector agency staff and biodiversity scientists to ensure that the statistics were developed in a robust manner, included best available information, and were relevant to agency requirements for reporting on biodiversity.

1.2 Linkages with other Tier 1 Statistics and Environmental Monitoring programmes

1.2.1 Other Tier 1 Statistics

Existing Tier 1 Statistics that relate to the Oceans include annual reporting on 'Fish Stocks' (lead agency: Ministry for Primary Industries), and on 'Marine Protected Areas' (lead agency: Department of Conservation). The Fish Stocks statistic reports on the status of commercial fish stocks but provides no information on biodiversity status of fishing areas. The 'Marine Protected Areas' statistic provides reporting on area (and trends in area) covered by both Type 1 (no-take Marine Protected Areas) and Type 2 protection (other management tools that meet the protection standard), but does not provide quantitative information on the overall well-being of marine biodiversity in New Zealand. Information is reported annually, and includes total area in protection in each of 14 coastal biogeographic regions.

Other Tier 1 Statistics in development include 'Coastal and Recreational Coastal Water Quality' (lead agency: Ministry for the Environment) and 'Ecological Integrity and Diversity' (lead agency: Department of Conservation). A concurrent project to develop the oceanic component of 'Atmosphere and Ocean Climate Change' (joint lead agencies: Ministry for the Environment and Ministry for Primary Industries) will evaluate metrics of physical variables that potentially drive patterns and changes in biodiversity (e.g., sea surface temperature, ocean acidification, net primary production, and sea surface height).

1.2.2 Other Environmental Monitoring and Reporting programmes

The Marine Environmental Monitoring Programme has developed a meta-database of existing long-term monitoring datasets in New Zealand that could provide data to support Tier 1 Statistics (Hewitt et al. 2014). The Marine Environmental Monitoring Programme has recommended a number of guidelines for monitoring data to be used in statistics: 1) monitoring data should represent or contribute to more than one State of the Environment aspect such as biodiversity, health, resilience, or integrity, or provide information on threats to these aspects; 2) taxa or habitats should be chosen based on their known response to climate change or other major stressors in appropriate locations; 3) monitored taxa or habitats should have low temporal variability in the absence of environmental stressors; 4) monitoring data should preferably already be monitored nationally and/or internationally, providing a baseline or comparative international information with which to evaluate change; and 5) monitoring data should be able to be well measured cost-effectively (Hewitt et al. 2014).

The Ministry for the Environment is currently updating its Environmental Monitoring Report. A number of regional monitoring programmes and report cards of ecosystem health are reported on regularly by regional councils (e.g., the Auckland Council 'State of Auckland' Marine Report Card, which includes reporting on water quality, contaminants, ecology and bathing beach water quality).

1.3 Strategic Relevance

Within the Statistics New Zealand Environmental Domain Plan for the Coastal and Marine Environment, a marine biodiversity reporting statistic will contribute to our understanding of the following 'enduring question': "How is the quality and use of our marine environment changing and what is the impact of human activity, including resource use, on the marine environment?" The marine biodiversity statistic will also facilitate and contribute to international reporting requirements on biodiversity to platforms and multilateral environmental agreements such as the Convention on Biological Diversity (CBD) and the International Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Reporting on the status of threatened taxa is also required under international agreements.

1.4 Project Objective

The project objectives were:

1. To evaluate the utility and feasibility of developing the variables published by Costello et al. (2010) as a Tier 1 statistic reporting on the state of marine biodiversity in New Zealand. The four proposed measures were:

- Species richness per square km;
- State of knowledge index;
- Proportion of endemic species; and
- Number of threatened species.

2. To host a collaborative and consultative workshop to introduce and discuss each potential marine biodiversity indicator for its usefulness as a Tier 1 statistic.

2. METHODS

2.1 Tier 1 National Reporting Statistics Principles and Protocols

The principles and protocols of Tier 1 statistics are presented as guidelines to underpin the development of new national reporting statistics (Table 1, Statistics New Zealand 2007). In developing new statistics for marine biodiversity, we focussed on a number of key principles, while recognising that all principles and protocols must be adhered to for Tier 1 National Reporting Statistics. Firstly, we strove to ensure that the statistics were 'relevant' to user requirements, both through collaborative workshops with relevant agencies and prospective users, and through evaluation of the key underlying questions that a marine biodiversity metric might address. A number of questions are proposed by Statistics New Zealand in their Environment Domain Plan 2013 for the Coastal and Marine Environment. Ideally a marine biodiversity statistic should be designed to demonstrate if change is occurring in the marine environment, and what spatial and temporal trends exist for any changes that are occurring. Further, a marine biodiversity statistic should impart knowledge to the general public on the phenomena itself, i.e., 'what is marine biodiversity?' Quality, particularly the quality of data used to prepare the official statistics, was also of particular importance for this marine biodiversity statistic, and is discussed below in our description of proposed datasets for calculating the statistic. Accessibility, as it relates to proposed datasets and their long-term availability and accessibility, is another important requirement, as was maximising the use of existing data sources. The final important component to be considered was efficiency and minimising respondent load, that is, demonstrating that the chosen metrics are the most efficient and cost-effective way to calculate a marine biodiversity statistic that answers key questions about changes in the state of New Zealand's marine biodiversity.

Table 1: Principles and protocols underlying Tier 1 Statistics (http://www.statisphere.govt.nz/tier1-statistics/principles-protocols.aspx).

	Topic	Description
1	Relevance	Official statistics produced by government agencies are relevant to current and prospective user requirements, in government and in the wider community
2	Integrity	Official statistics gain public trust by being produced and released using objective and transparent methods
3	Quality	Official statistics are produced using sound statistical methodology, relevant and reliable data sources, and are appropriate for the purpose
4	Coherence	The value of statistical data is maximised through the use of common frameworks, standards and classifications
5	Accessibility	Access to official statistics is equal and open
6	Efficiency	Official statistics agencies strive to be efficient and provide value for money
7	Protecting respondent information	Respondents' rights to privacy and confidentiality are respected and their information is stored securely
8	Minimising respondent load	The costs of compliance are kept to an acceptable level and data is collected only when the expected benefits of a statistical survey exceed the imposition on providers
9	Maximising existing data sources	Maximise the use and value of existing data by integrating or aligning available statistics and administrative resources
10	International participation	Official statistics agencies make use of and contribute to international statistical developments

2.2 Relevance of proposed marine biodiversity metrics

A key aspect of Tier 1 statistics is whether the statistics are relevant to user requirements. For marine biodiversity, we interpret potential users of marine biodiversity statistics to be broad, including management agencies which require marine biodiversity statistics for national and international reporting, both on the state of knowledge of the marine estate, and on trends in threatened species abundance. Trends in the abundance of endemic marine species (or, their non-indigenous counterparts) are also indicators of the wellbeing of marine biodiversity. A primary user of Tier 1 statistics is also the general public; as such, a marine biodiversity statistic can be interpreted as relevant if it provides information that reports on aspects of what marine biodiversity is, and what makes New Zealand's marine biodiversity unique.

Features of marine biodiversity such as our relatively high national biodiversity, and the high levels of endemism for many taxonomic groups, are key aspects to incorporate in this statistic. Reporting on changes in the status of threatened and non-indigenous marine taxa is also of interest to the general public, with both threatened and non-indigenous taxa receiving widespread public attention. Finally, the state of knowledge indicator is relevant to broad public interest in reports of new species found on New Zealand scientific expeditions, and general acknowledgement of the value of the quest for increasing the knowledge of New Zealand's marine estate. Finally, information on biodiversity can also contribute to the marine economy, through documenting presence and distribution of potential resources that can be extracted from the oceans, and providing a baseline for assessment of sustainable use. As such, we suggest that each of the proposed metrics (the number of species that have been found in New Zealand waters (species richness), state of knowledge, endemic species, and threatened species) is relevant and meaningful as a Tier 1 marine biodiversity statistic. We further evaluate these statistics with respect to our current ability to measure these metrics, and suggest variations in the proposed metrics that provide more direct reporting with respect to changes in our state of knowledge and of the wellbeing of marine biodiversity.

2.3 Workshop outcomes

This project required a collaborative and consultative approach to ensure that the statistics were developed in a robust manner and were in accordance with official Tier 1 statistic guidelines. An initial workshop was held on 17 December 2013 to further develop the proposed statistics with other agency staff, and discuss linkages with other Tier 1 statistics and national environmental monitoring programmes. Organisations represented at the meeting included NIWA, University of Auckland, Ministry for Primary Industries, Department of Conservation, and Ministry for the Environment. NIWA presented preliminary investigations into the suitability of the Costello et al. (2010) metrics for use for reporting on marine biodiversity in the New Zealand marine region. A second workshop was held on 11 March 2014, and included representatives from Ministry for Primary Industries, Department of Conservation, Ministry for the Environment, Statistics NZ, Auckland Council, and NIWA. The objective of this second workshop was to discuss and recommend final reporting statistics, and confirm that the statistics were consistent with the guidelines and protocols for Tier 1 reporting statistics, and were consistent with objectives for use by various national agencies.

Key workshop discussion items included:

1) <u>Ability to report on changes in species richness.</u> Early in the evaluation it became apparent that reporting on changes in species richness would not be possible due to present data limitations and lack of broad-scale monitoring programmes. Instead we focussed on recording the process of gathering data as representing New Zealand's commitment to knowledge of the biodiversity of its marine estate.
2) <u>Appropriate scale for reporting on spatial patterns in records of species occurrences.</u> Spatial representations of data availability at 1 km × 1 km, 10 km × 10 km, and 100 km × 100 km grid cells were presented, and general agreement was that the 100 km × 100 km grid cells were most useful at presenting patterns in species richness, whereas the smaller grid cells resulted in a

majority of empty cells, and made visual patterns difficult to interpret. Presentation of all three scales was requested for the contract report, as demonstration of this decision-making of appropriate scale for data summation.

3) Temporal scale of reporting. Some metrics (e.g., endemic proportion) are unlikely to change significantly between five yearly reporting intervals. Rather, reporting on the number of newly recorded invasive species would be more appropriate to illustrate this concept of changes in native species proportions. This contract report will present options for reporting on changes in taxonomic composition (endemic, invasive, etc.) as well as suggesting ways to report on changes in state of knowledge over five year intervals.
4) Level of taxonomic reporting. The consensus was that while it is anticipated that a broad list of taxonomic categories would be chosen for the national statistic, in this report, we will present three options of different resolution for taxonomic resolution.
5) Data availability. It was agreed that while a number of records are in the Ocean Biogeographic Information System (OBIS), many of the national marine biodiversity collections (e.g., NIWA invertebrates, FishAtlas, Te Papa datasets) are either not in OBIS, or have not been recently updated in OBIS. While databases should continue to be updated in future in OBIS, the consensus of workshop participants was that the national statistic should include best available information, and not solely OBIS data. The project team has further investigated all known datasets, and presents in this report summaries of which datasets were included based on adherence to the Tier 1 National reporting standards in Table 1.
6) Data quality. Concerns were raised about the quality of data in OBIS and other datasets (both issues of taxonomic expertise and accuracy of point locations), challenges with overlaps between datasets, and challenges due to changing taxonomic information and how these changes would be incorporated into a national statistic. For all datasets used, caveats are presented in this contract report to address issues of data quality.
7) Threat classification. It is recognised that threat classification and availability of assessments vary strongly among taxa; for example mammals and birds may have higher proportions of assessed taxa than for example marine invertebrates and macroalgae. Consensus was reached that reporting on threatened taxa was still valuable for the reporting statistic, with expectation that the reporting would also include the proportion of taxa assessed within a taxonomic grouping.

2.4 Available datasets

2.4.1 Ocean Biogeographic Information System (OBIS)

OBIS publishes datasets on marine species distribution in space and time. Datasets may be from field surveys (e.g., plankton, fishery trawl, benthic cores, whale and bird observations), specimen collections, and other taxonomic observations. OBIS originated as part of the information management component of the Census of Marine Life, and is now housed within the Intergovernmental Oceanographic Commission (IOC) of UNESCO, under its International Oceanographic Data and Information Exchange (IODE) programme. As of December 2013, over 37.7 million records had been uploaded into OBIS, including approximately 145 000 species and downloaded from 1456 different international datasets or organisations (http://iobis.org). OBIS data include all groups of organisms that are associated with marine (including estuarine) habitats, i.e., marine vertebrates (fish, marine mammals, marine reptiles, etc.), marine invertebrates, marine bacteria, and marine plants (phytoplankton, macroalgae, seagrass, mangroves). OBIS preferably works through linkages with a number of regional nodes; the South Western Pacific Node is hosted by NIWA and manages twelve regional databases (Appendix 1). Other international databases (i.e., not part of the South Western Pacific Node) also contribute species records within the New Zealand EEZ. All data are open access, and responsibility for data quality, including updating records, is the responsibility of the data collector (Box 1). Data include only species name as taxonomic identification; all further taxonomic information is accessed via the World Register of Marine Species (WoRMS) database.

Box 1: OBIS information relating to Data Quality of OBIS data records.

Quality control of OBIS data (based on http://iobis.org)

Data published through OBIS must come from credible, authoritative sources. The scientists and institutions responsible for collecting and managing the data are clearly named. Before publication, the data must pass through a series of technical controls described below, and these are repeated every time the data may be accessed again from its source. Any errors, such as species name misspellings, names not recognised in OBIS, and possible mapping errors, are reported to the data provider to review, and if necessary, correct. Thus the next time the data are published they are more correct, and the source database quality is also improved. Data use is a very important way of finding actual and possible errors in data. Users may contact the data source directly or OBIS with such issues.

The OBIS Quality Control protocol is as follows:

1. If the required data fields are not properly filled, notification will be sent to the Data Provider. No further action will be taken until the required fields are filled.
2. If fields have questionable values, notification will be sent to Data Provider. These questionable values will be set as empty in the data published.
3. Data located on land will be reported to the Data Provider but will not be deleted unless instructed by the Data Provider, because they may represent a species in an estuary or the centre point of a location. If a Data Provider changes the values, new values will show up after the next round of data upload.
4. If species names cannot be (a) verified against known valid names in OBIS, or (b) to the OBIS taxonomic hierarchy, or (c) the World Register of Marine Species (WoRMS) the Data Provider will be notified so they can check they are current and correct. Names that cannot be placed after checking with WoRMS and OBIS are, where possible, placed on the basis of other authoritative sources, such as the Catalogue of Life or the Integrated Taxonomic Information System (ITIS). Some non-verified names may be assigned a position in the taxonomic hierarchy by virtue of their genus.
5. The portal staff will communicate with data providers to inform them of any problems and improve data quality. They will check that the data conform to the metadata description of the dataset; i.e., it should have the correct number of records and species in the right geographic locations. After the data is transferred to the server from where it will be published online, a form email will be sent to the technical person and manager specified, detailing number of records obtained and missing records if applicable, time of next accessing, and any errors identified.

2.4.2 World Register of Marine Species (WoRMS)

The World Register of Marine Species (WoRMS) is the authority for names of all marine species including synonyms and standardised higher classification. While the New Zealand Organism Register (NZOR) is the national source for taxonomic nomenclature, discussion by experts at the initial project workshop suggested that NZOR will soon have a direct electronic link with WoRMS for updating any New Zealand species names or taxonomy. As such, the expert taxonomists suggested that WoRMS be used as the primary source for taxonomy to support the marine biodiversity statistic, as it is regularly updated, and is international in scope. The OBIS toolbox includes a function that links species records to their corresponding taxonomic authority in WoRMS for updating to the current taxonomy.

2.4.3 Databases held by NIWA

NIWA holds a number of national (New Zealand government funded) biodiversity collection records that have not been uploaded to OBIS; many of these databases are scheduled for upload to OBIS in 2014. SPECIFY includes electronic data corresponding to all samples held within the NIWA marine invertebrate collection. An earlier iteration of the SPECIFY dataset (2006) has been uploaded to OBIS. AllSeaBio, also on OBIS, was an early iteration of SPECIFY, and does contain some overlap of information. However, AllSeaBio also includes a number of records that are not held within SPECIFY (i.e., records for which samples were not preserved and stored in the NIWA marine invertebrate museum); many of these are historical species records.

Other national taxonomic datasets hosted by NIWA, some of which have been uploaded to OBIS, include sponges, arthropods, bryozoans, cold water corals, coralline algae, and asteroids. Revised versions of many of these datasets exist at NIWA, and are in the process of being uploaded to OBIS. There is some, but not complete, overlap between specific taxonomic databases and SPECIFY, depending on how many records were retained in the NIWA invertebrate collections; this overlap varies among taxonomic datasets.

NIWA also hosts the Ministry for Primary Industries research trawl database and observer databases (also known as the Fish Communities Databases, COD and TRAWL). Records from COD and TRAWL are included in SPECIFY for any taxa that are provided to the NIWA invertebrate collection for further taxonomic resolution. The Fish Communities Database (fish_comm) has previously been uploaded to OBIS (database listed as South Western Pacific Regional OBIS Data provider for the NIWA Marine Biodata Information System), with an updated database in the process of uploading to OBIS in 2014. Fish_comm, though including only fishes and squids, contains a majority of the species records in the New Zealand EEZ.

2.4.4 Macroalgal collections and herbarium data in New Zealand

The major New Zealand macroalgal collections are held in the herbaria of the Museum of New Zealand Te Papa Tongarewa (WELT), Landcare Research Manaaki Whenua (CHR) and at the Auckland Museum (AK) (Thiers 2014). The herbarium at Te Papa (WELT) is the only collection in New Zealand where there has been consistent expert taxonomic attention to the macroalgae over the past 50 years. The WELT collections have been databased over a period of about 15 years. The recent focus within the herbarium has been on improving collection data and checking the dataset for errors, particularly grooming collection date data and mapping and verifying locality data. Because WELT collections have received expert identification and curation, they have been used as the primary source of data on the distributions of marine macroalgae for a number of research projects and government databases (e.g., Booth et al. 2006). WELT is also where voucher specimens have been deposited (e.g., for the Marine Invasives Taxonomic Service, contracted to NIWA by the Ministry for Primary Industries). Nelson et al. (2013) summarised the history of the collections in WELT and used these collections to review the state of knowledge of the New Zealand macroalgal flora.

Much of New Zealand macroalgal taxonomic and biogeographic literature is based on the WELT collections including Adams (1994) and a series of regional floral lists (Adams 1972, Adams et al. 1974, South & Adams 1976, Nelson & Adams 1984, Adams & Nelson 1985, Hay et al. 1985, Nelson & Adams 1987, Nelson et al. 1991, Nelson et al. 1992, Neale & Nelson 1998, Nelson et al. 2002, also Nelson & Dalen in press) based on targeted collections. In addition some specific projects have been undertaken to improve collections and knowledge of the flora (e.g., coralline algae, Broom et al. 2008, Harvey et al. 2005, Farr et al. 2009; macroalgae from soft sediment environments, Neill et al. 2012; Ulvaceae, Heesch et al. 2007, 2009). In the absence of a complete flora, there has been considerable recent effort directed to compiling and updating lists of currently accepted names and the taxonomic hierarchy, with published lists produced as part of the Species 2000 project documenting the New Zealand biota (Broady et al. 2012, Harper et al. 2012, Nelson 2012), and also updated current lists provided on the Te Papa website (e.g. Dalen & Nelson 2013 a-c).

As this macroalgal dataset showed consistent taxonomic attention, long-term viability and accessibility, and high data quality, this dataset was recommended to be included in the calculation of a marine biodiversity statistic. Permission to use the existing groomed macroalgae dataset was requested from Te Papa, and the dataset was provided.

2.4.5 Other datasets considered

A number of datasets that were used for previous biodiversity exercises (e.g., Beaumont et al. 2008) were explored for their potential to be included in the Marine Biodiversity statistic. Data quality and taxonomic resolution varied among datasets, with many datasets consisting of taxonomic groupings (e.g., foliose macroalgae) rather than species records, or consisting of modelled data outputs (Beaumont et al. 2008). For this statistic, we determined that modelled data should not be included, and that individual species records, rather than assessments of percent cover of broad taxonomic groups, are required for inclusion (though in some cases, taxonomic resolution of individual species is available only to Family or Order). Another key consideration was the ease of access and whether cost was involved to acquire a dataset. We opted to exclude datasets for which funds had previously been required for access. Rather it is hoped that future funding to support the Marine Biodiversity Statistic will include funding to support upload of high quality datasets to OBIS, so that in future, they may be included in this statistic.

We recognise a few high quality datasets that should be prioritised for any potential funding:

- A large, high quality database of mollusc records is held by Te Papa, but is not yet uploaded to OBIS. As this dataset was previously only available for purchase (Beaumont et al. 2008), we opted to rely on the substantial existing information in OBIS and NIWA datasets to represent molluscs.

- The Marine High Risk Site Surveillance database contains data on invasive species presence, as recorded in annual port surveys within selected harbours in New Zealand. These surveys are designed to detect establishment of a pre-determined list of high risk species in a limited number of ports, which are the most likely point of entry for most NIMS taxa.

- The Ornithological Society of New Zealand holds a large dataset containing records from regular surveys of wading birds in New Zealand in 150 estuaries nationwide. As this dataset was previously only available for purchase (Beaumont et al. 2008), we opted to rely on the substantial existing information in OBIS datasets to represent wading birds.

- Various datasets are available on marine mammal sightings, including from research surveys, Department of Conservation surveys, tourism records, and commercial surveys. The Department of Conservation is currently developing a national database and information protocol for these records, and in future, this information could be uploaded to OBIS.

2.5 Dataset workflow

2.5.1 OBIS

All taxonomic records from OBIS were extracted from within the New Zealand EEZ, including all historical data to 31 December 2013. A total of 527 441 OBIS records were extracted representing 10 974 individual species; of these approximately 20% were from databases not held within the South Western Pacific node (i.e., not databases held in New Zealand) (Table 2).

For further processing, the following New Zealand datasets were excluded from the OBIS dataset, as updated versions existed as part of the current SPECIFY database, though not yet uploaded to OBIS: South Western Pacific Regional OBIS Data SPECIFY Subset (2006 version); South Western Pacific Regional OBIS Data Asteroid Subset; and South Western Pacific Regional OBIS Data Habitat-forming Cold Water Corals Subset. Other NIWA taxonomic subsets (e.g., Bryozoa) were determined to not yet be fully registered within SPECIFY, and the potential for overlap was preferred rather than loss of a large proportion of taxonomic records for this group. For comparisons of records between national datasets and other international datasets, all data hosted by NIWA for the South Western

Pacific OBIS node was classified as 'New Zealand' data; all other international datasets available on OBIS were classified as 'OBIS' datasets.

Table 2: OBIS databases with species records within the New Zealand EEZ. Datasets in italics were replaced with updated datasets as available with NIWA.

OBIS Dataset	# records	# taxa	Provider name
East London Museum	124	80	AfrOBIS
South African Institute for Aquatic Biodiversity - Fish Collection	13	12	AfrOBIS
iziko South African Museum - Fish Collection	1	1	AfrOBIS
iziko South African Museum - Marine Mammal Collection	4	2	AfrOBIS
iziko South African Museum - Shark Collection	100	13	AfrOBIS
Polycystine Radiolarians from the water column and the surface sediments of the World Ocean	780	141	Argentinean RON
ABBBS Bird Banding records from the Australian Antarctic Territory and Heard Island.	4	1	Australian Antarctic Data Centre
ARGOS Satellite Tracking of animals	64	1	Australian Antarctic Data Centre
Inventory of Antarctic seabird breeding sites	4	1	Australian Antarctic Data Centre
National Whale and Dolphin Sightings and Strandings Database	27	11	Australian Antarctic Data Centre
Seabirds of the Southern and South Indian Ocean	147	28	Australian Antarctic Data Centre
Southern Ocean Continuous Zooplankton Recorder (SO-CPR) Survey	643	28	Australian Antarctic Data Centre
Australian Institute of Marine Science - Bioresources Library	9	9	Australian Institute of Marine Science
BOLD Marine Invertebrate Data	14	7	BOLD
BOLD Public Fish Data	12	6	BOLD
SeamountsOnline (Seamount Biota)	1 275	262	CoML
TOPP Fish (TOPP)	10	1	CoML
ZooGene A DNA Sequence Database for Calanoid Copepods and Euphausiids	20	10	CoML
CeDAMar database for benthic biological sampling on the abyssal plains	135	84	EurOBIS
ChEssBase	1	1	EurOBIS
Cold water corals	847	103	EurOBIS
Galathea II, Danish Deep Sea Expedition 1950–52	476	301	EurOBIS
PANGAEA - Data from Christian-Albrechts-University Kiel	162	19	EurOBIS
PANGAEA - Data from Climate: Long-range investigation, mapping and prediction (CLIMAP)	1	1	EurOBIS
PANGAEA - Data from Leibniz Institute of Marine Sciences	473	21	EurOBIS
PANGAEA - Data from paleoenvironmental reconstructions from marine sediments @ AWI	121	24	EurOBIS
PANGAEA - Data from the Deep Sea Drilling Project (DSDP)	19 350	605	EurOBIS
PANGAEA - Data from the Ocean Drilling Program (ODP)	7 426	263	EurOBIS
PANGAEA - Data from various sources	859	126	EurOBIS

OBIS Dataset	# records	# taxa	Provider name
Senckenberg's collection management system	70	39	EurOBIS
Coleccion de referencia de otolitos, Instituto de Ciencias del Mar-CSIC	2	2	FishBase
Fish specimens	11	9	FishBase
Fishbase occurrences hosted by GBIF-Sweden	343	178	FishBase
Ichtyologie	77	47	FishBase
Hexacorallians of the World	1 280	189	Hexacorals
MICROBIS database	64 880	602	ICoMM
World Ocean Database 2009	1 662	251	NODC
Marine Biological Sample Database, JAMSTEC	96	30	OBIS Japan
BIOMASS 1980–1985	42	15	OBIS-SEAMAP
Cemetery Beach Port Hedland Flatback Tracking Project 2009/2010	1	1	OBIS-SEAMAP
Historical distribution of whales shown by logbook records 1785–1913	1 094	3	OBIS-SEAMAP
SMRU Elephant Seal Pup Tracking 1995–1996	47	1	OBIS-SEAMAP
Stranded spade-toothed beaked whales in New Zealand in 2010	1	1	OBIS-SEAMAP
TOPP Summary of SSM-derived Telemetry	230	1	OBIS-SEAMAP
Bishop Museum Data (OBIS distribution)	6	6	OBIS-USA
CephBase	22	8	OBIS-USA
Ocean Genome Resource	529	74	OBIS-USA
Australian Museum	55	11	OZCAM
MV Ichthyology	26	14	OZCAM
MV Marine Invertebrates	41	23	OZCAM
MV Ornithology	38	14	OZCAM
Amphipoda Hyperiidea of the Southern Ocean: catalogue and occurrences	47	16	SCAR-MarBIN
Antarctic Amphipod Crustaceans: Ant'Phipoda Database (BIANZO)	83	45	SCAR-MarBIN
Antarctic Isopods	2	2	SCAR-MarBIN
Antarctic Marine Species Sequence Data	3	1	SCAR-MarBIN
Biogeographic distribution of Antarctic and sub-Antarctic Cumacea	1	1	SCAR-MarBIN
Biogeographic distribution of the Antarctic and Sub-Antarctic brachiopods (living forms)	64	9	SCAR-MarBIN
Collections data on ecology of bottom animal of the Southern ocean	4	4	SCAR-MarBIN
Nemertina World Checklist	1	1	SCAR-MarBIN
SO-Polylist	1	1	SCAR-MarBIN
SOMBASE BIOCONSTRUCTORS	1 644	592	SCAR-MarBIN
SOMBASE PYCNOGONIDS	217	73	SCAR-MarBIN
NMNH Invertebrate Zoology Collections	2 969	1 119	Smithsonian Institute
NMNH Vertebrate Zoology Fishes Collections	188	113	Smithsonian Institute
NIWA plankton	4 200	200	South Western Pacific OBIS
New Zealand Coralline Algae	557	30	South Western Pacific OBIS
South Western Pacific Regional OBIS Data All Sea Bio Subset	32 597	2 457	South Western Pacific OBIS
South Western Pacific Regional OBIS Data Asteroid	*2 023*	*114*	*South Western Pacific*

OBIS Dataset	# records	# taxa	Provider name
Subset			*OBIS*
South Western Pacific Regional OBIS Data Bryozoan Subset	5 545	558	South Western Pacific OBIS
South Western Pacific Regional OBIS Data Habitat-forming Cold Water Corals Subset	*588*	*5*	*South Western Pacific OBIS*
South Western Pacific Regional OBIS Data Specify Subset	*7 212*	*1 467*	*South Western Pacific OBIS*
South Western Pacific Regional OBIS Data provider for the NIWA Marine Biodata Information System	365 775	435	South Western Pacific OBIS
Catalogue of Squat Lobsters	20	19	SquatLobsters
Academy of Natural Sciences OBIS Mollusc Database	45	31	The Academy of Natural Sciences
Total (all OBIS data records)	**527 441**	**10 974**	
Total South Western Pacific OBIS (New Zealand)	**418 497**	**5 266**	

OBIS data columns include 97 available information categories ranging from record identification, spatial position, species name, collector information, physical parameters at the collection location, and temporal information. Key information required for analyses for a marine biodiversity indicator included: record ID, latitude, longitude, date collected, date last modified on OBIS, species name, and source of record. A tool exists to convert species names to complete taxonomic information (Phylum, Class, Order, …) that links OBIS with WoRMS, but this tool is limited to small datasets (fewer than 2000 records at a time). Because over 500 000 records in OBIS required conversion, conversion of OBIS species information using WoRMS was not completed in this project (Table 2). Instead, data records were downloaded from OBIS for taxonomic subsets (e.g., Porifera, Cnidaria), providing for higher levels taxonomic groupings within ArcGIS analyses. This also got around issues within the OBIS dataset where taxa were not identified to species, and instead taxonomic information was available only at higher taxonomic levels.

2.5.2 SPECIFY

All taxonomic records from SPECIFY were extracted from within the New Zealand EEZ, including all historical data to 31 December 2013. A total of 66 690 SPECIFY records were extracted representing 7556 individual species. Thirty seven SPECIFY data columns were extracted, providing information on record identification number, latitude, longitude, taxonomic information, date of collection, date of identification and modification, and collector information. It was assumed that all taxonomic information was current with information available in WoRMS and NZOR, due to quality control within the SPECIFY database. Commercially sensitive records (i.e., records logged relating to particular commercial ventures such as phosphate mining or oil and gas exploration) were excluded from the data extraction. In some cases, records in SPECIFY are recorded as 'lots', i.e., where a sample container included more than one species. All multiple record lots in SPECIFY were separated prior to extraction into individual records representing individual species.

2.5.3 Macroalgal datasets

Macroalgal records were extracted from the database of the Te Papa herbarium. All New Zealand marine algal records current to December 2011 were exported into Excel spreadsheets. In the absence of a published flora, a current species names list and taxonomic hierarchy is maintained on the Te Papa website (http://www.tepapa.govt.nz/ - Dalen and Nelson 2013a-c). Changes to current taxonomic names and classification have been drawn from primary literature and updated into Te Papa's database and the application of name changes to the collections has also been part of this effort. The number of taxa includes all recognised entities present in the collections, including some that have been recognised as distinct at a family, genus or species level but are currently unnamed. It is important to note that:

- the publicly accessible flora lists (Dalen and Nelson 2013a-c) include only published names, including some published tag names;
- not all published taxa are represented in the WELT collections; and
- there are more taxa recognised as being distinct than have been published currently.

The Green algae or Division Chlorophyta includes data for three classes, Prasinophyceae, Ulvophyceae, and Trebouxiophyceae. (There are no marine macroalgal Chlorophyceae represented in Te Papa's collections.) The Brown algae or Ochrophyta include members of the classes Chrysomerophyceae, Xanthophyceae, and Phaeophyceae, and the Red algae or Rhodophyta are represented by members of four classes, Compsopogonophyceae, Stylonematophyceae, Bangiophyceae, and Florideophyceae. Eleven data columns were extracted, providing information on record and taxonomic identification, collection location and date, and collector for each of 19 422 records representing a total of 1028 individual species.

2.5.4 Geoprocessing

Records were provided in the geospatial datum WGS84 (World Geodetic System 1984) which is a standard projection, and used by GPS (Global Positioning System) with which the sampling location of many species records are located. All records (OBIS, SPECIFY, Te Papa) were provided in WGS84 projection, and no conversions were required. A total of 608 280 records were available from the combined OBIS, SPECIFY and Te Papa datasets.

ArcGIS standard geoprocessing tools were used to calculate sums of records within a custom grid, beginning at the northwest corner of the NZ EEZ. Grids were created for 1 km × 1 km grid cells, 10 km × 10 km grid cells, and 100 km × 100 km grid cells. To calculate the number of species from the record database, we used the Marine Geospatial Ecology Toolbox (MGET). MGET is a collection of free, open source software tools that provide standard geoprocessing for marine ecology, including tools to convert OBIS records to species richness (http://mgel.env.duke.edu/mget).

Additional calculations were investigated that could allow for evaluation of sampling effort bias when determining patterns of species richness. We investigated ES50 (estimated species in random 50 samples), Chao statistics (estimates species richness based on samples in spatial unit), and calculation of the number of phyla per grid cell as ways of evaluating sampling effort bias and completeness of the species record.

However, we determined that additional calculations using any of these tools were not cost-effective based on current knowledge of biodiversity, and were unlikely to provide information not already available in plots of spatial patterns in species richness, which demonstrate nearly identical spatial patterns in species richness as those in species records (see Section 3). The sampling bias is substantially skewed, with the majority of 100 km × 100 km cells having fewer than 100 total records, and few areas (coastal areas, Chatham Rise) with high sampling effort (more than 1000 records). As such, the more complex metrics that reduce sampling bias are unable to overcome the substantial bias in sampling effort and would show similar patterns to that of the number of records and the number of species. In future, should sampling effort resolve gaps in spatial knowledge, these additional calculations would be worth exploring.

3. SPECIES RICHNESS

Costello et al. (2010) reported species richness for New Zealand as the combined number of species recorded per total area of the New Zealand EEZ. The proportion of all species within each of fourteen major taxonomic groupings (e.g., Crustacea, Mollusca) was also reported, showing similarities across most bioregions in dominance of marine biodiversity by Crustacea, Mollusca, and Pisces (Costello et al. 2010). The proposed reporting statistic for species richness would thus adapt the Costello et al.

(2010) statistic to report on the number of records per area at a sub-national scale, ideally 1 km × 1 km.

For the species richness reporting statistic, we determined that this metric could provide information relating to two aspects of marine biodiversity:

- What are national estimates of marine biodiversity in terms of the total number of species accumulated since records start across taxonomic groups?
- What are spatial trends in this national estimate of biodiversity?

For the species richness metric, we were unable to determine temporal trends in biodiversity at the broader NZ EEZ scale, as records of species are given as presence only records (i.e., not including information on what is not found during a sampling event). Temporal trends in biodiversity would require structured, repeated sampling of species diversity to determine whether increases or decreases in species richness were occurring. In effect, the available data for species richness at a national scale is contributing information on our state of knowledge of marine biodiversity, but it cannot currently provide information on the status or trends in marine biodiversity.

To determine optimal reporting of species richness, we discuss recommendations for:

- Spatial scale of reporting
- Datasets to be included
- Temporal scale of reporting
- Taxonomic resolution
- Reporting of Records vs. Species

3.1 Spatial scale of reporting

While the proposed reporting metric was for species richness within 1 km × 1 km grid cells, the availability of species records suggested that coarser resolution was required in order to adequately quantify and view species richness, due to the sparsity of records throughout much of the EEZ (Figure 1). Comparisons between spatial scales (10 km × 10 km, Figure 2; 100 km × 100 km, Figure 3) suggest that species records are too sparse for adequate reporting at a scale less than 100 km × 100 km.

Even at the 100 km × 100 km scale, roughly half (269 of 540 grid cells) had low numbers of species records (fewer than 50) and number of species (Figure 3, Figure 4, Table 3); however, patterns of species richness in locations with high sampling effort (i.e., coastal cells, Chatham Rise) were evident at this highest scale, although these patterns are likely to be due primarily to sampling effort at this point in our understanding of New Zealand's biodiversity. Patterns were consistent between species records and species richness; however because of the spatial bias in sampling effort, it is premature at this stage to confirm that these patterns represent hotspots of biodiversity (Figure 3, Figure 4).

Comparisons between the number of species and the number of records in each cell indicate linear correlations between sampling effort and the number of species, suggesting that species diversity information is not yet sufficient to reach asymptotic levels of species present for most taxa, although it is likely that species richness is reaching an asymptote with increasing sampling effort for one better known group of ray-finned fishes (Actinypterygiae) (Table 3, Figure 5).

Figure 1: Point locations of all records across all biodiversity databases.

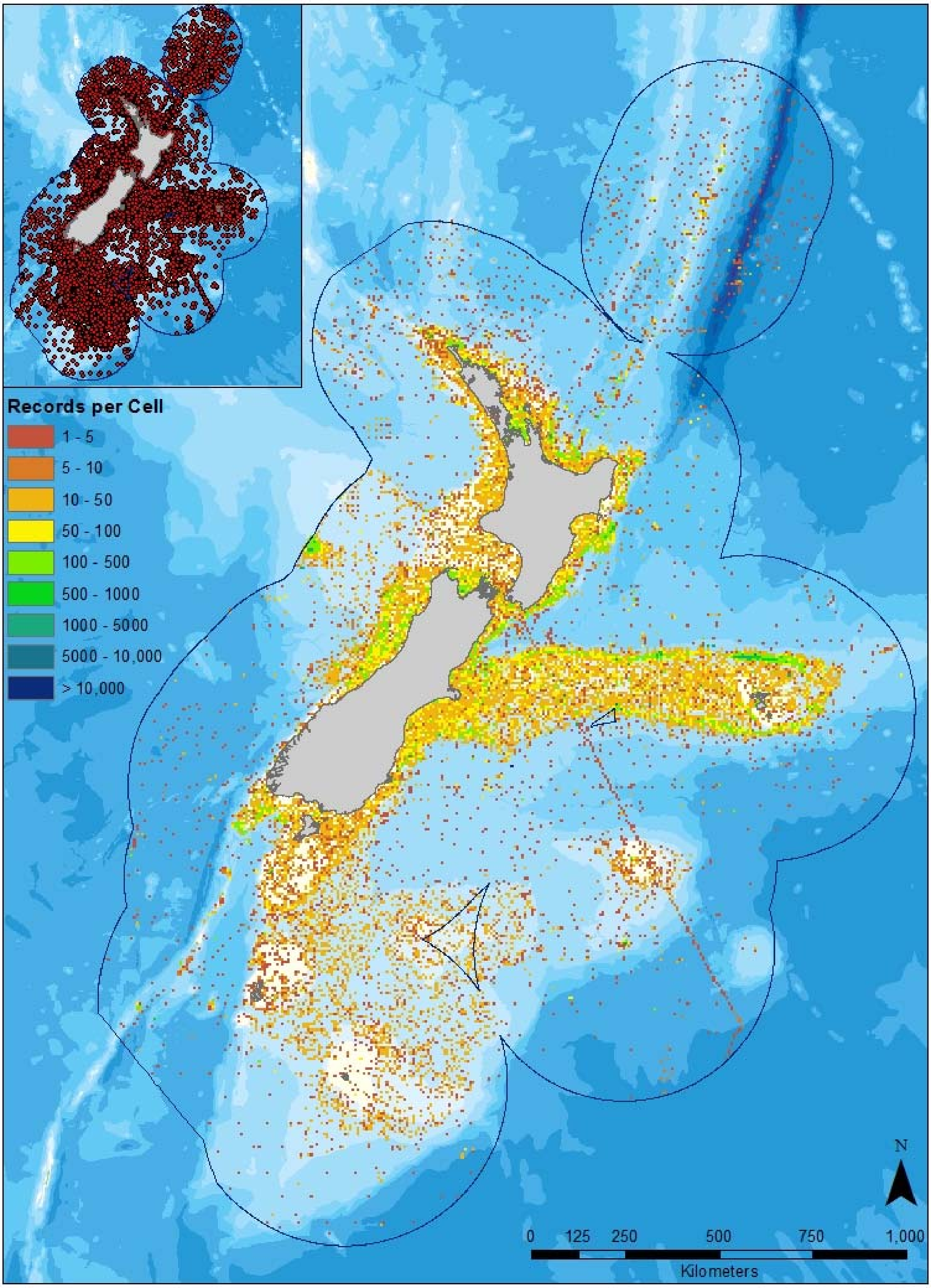


Figure 2: Number of taxonomic records per grid cell from all databases at grid scale of 10 km × 10 km.

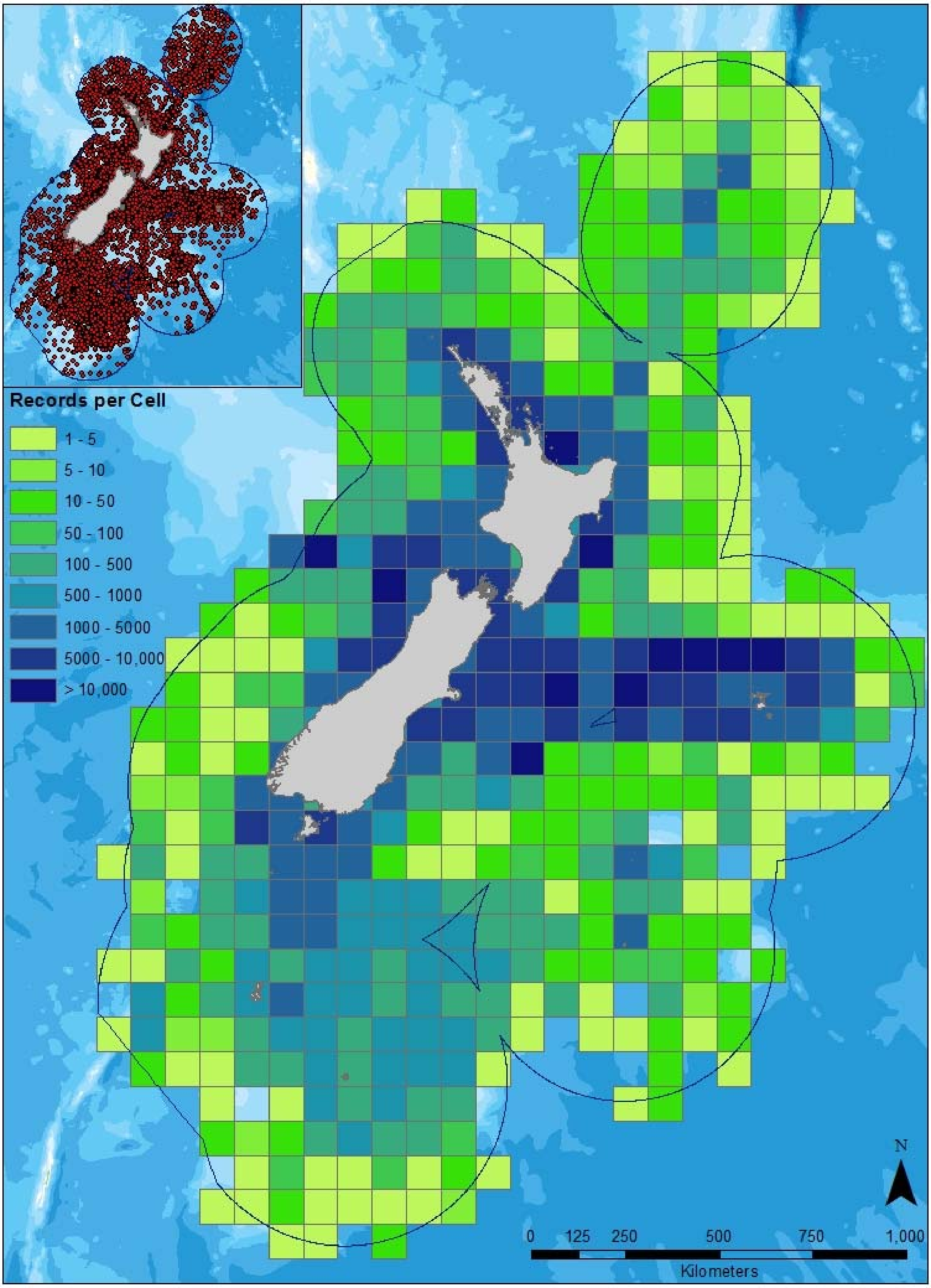


Figure 3: Number of taxonomic records per grid cell from all databases at grid scale of 100 km × 100 km.

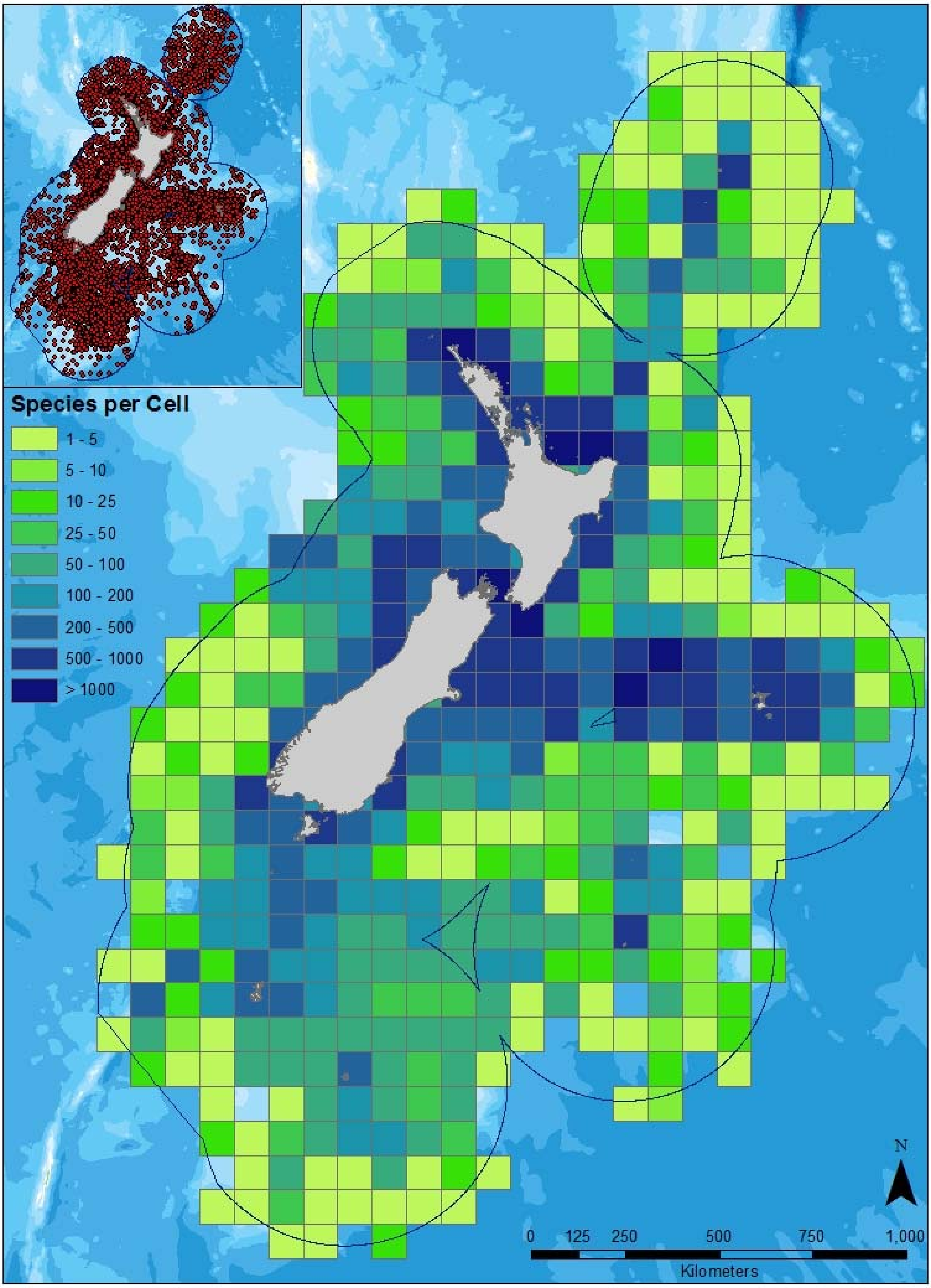
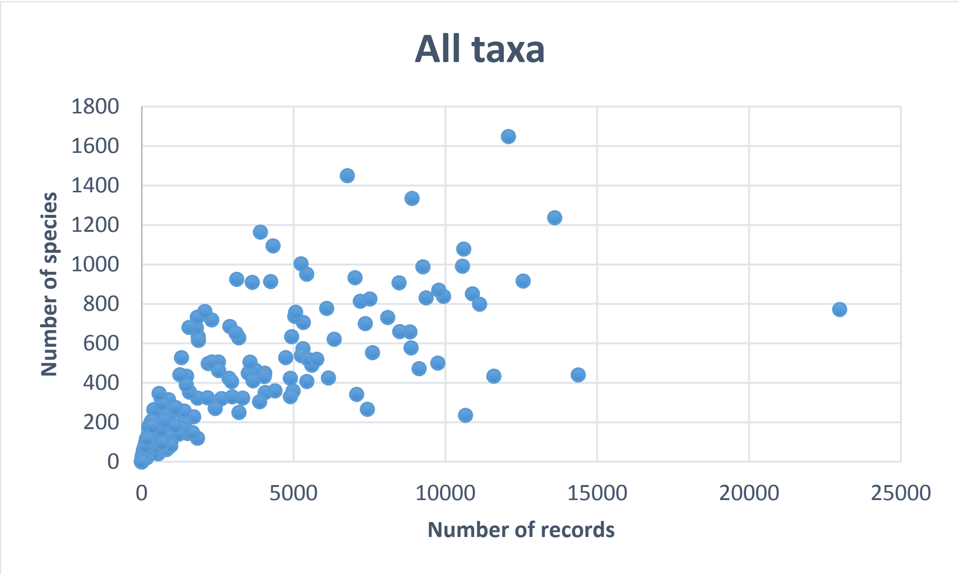


Figure 4: Number of species recorded per grid cell from all databases at grid scale of 100 km × 100 km.

Table 3: Distribution of records and number of species from all databases across grid cells.

Number	Number of species	Number of records
0	60	60
1	63	40
2	29	21
3	12	11
4	11	8
5	7	12
6–10	23	29
11–20	36	32
21–30	28	22
31–50	30	34
51–100	73	37
101–500	112	79
>501–1000	48	49
>1001–5000	8	61
>5001–10000	0	34
>10000	0	11
Total # cells	540	540
Max value	1648	22986



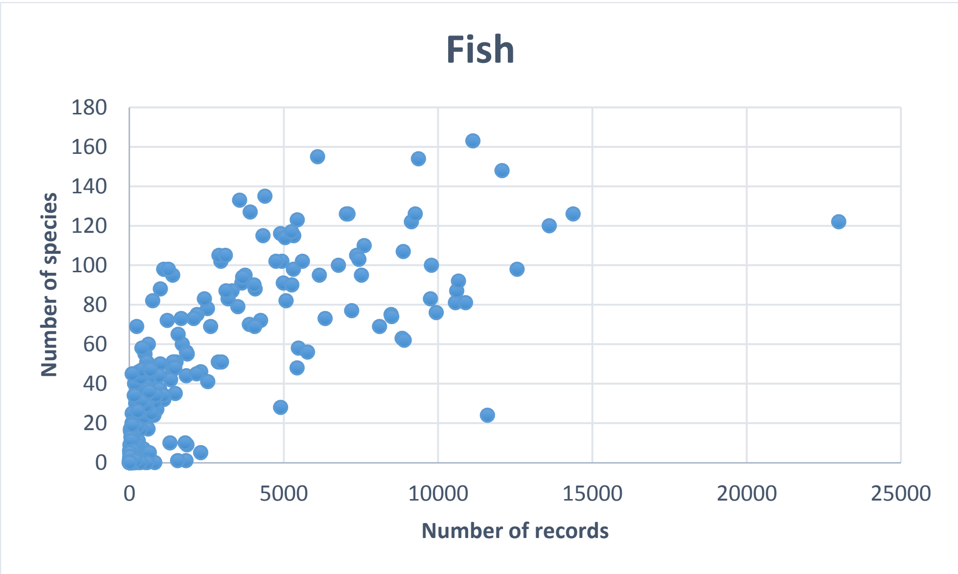


Figure 5: Species richness (number of species recorded per grid cell) from all taxonomic records at grid scale of 100 km × 100 km versus number of records for all taxonomic groups (top); Actinypterygiae (ray-finned fishes) (bottom).

3.2 Datasets to be included

While the initial contract objectives suggested using datasets accessible using Census of Marine Life / OBIS, we recognised that a number of high quality, national datasets either were not uploaded to OBIS, or had updated versions held by NIWA or Te Papa that were planned for future upload. Additional international datasets that may not be subject to the same quality control as New Zealand datasets (although see Box 1 for OBIS requirements for data quality) are available on OBIS; while some national expert taxonomists were hesitant to include these datasets due to their uncertain quality, plots of spatial distribution of records comparing New Zealand held datasets (including those held on OBIS) and other international datasets held on OBIS show differences in spatial coverage, with other international OBIS datasets covering many regions of the EEZ that are not covered in New Zealand datasets (Figure 6, Figure 7).

International (non-New Zealand) OBIS records include approximately 20% of all species records in the New Zealand EEZ (Table 2), and most are described as being quality collections from other reputable national and international sources. Patterns of species richness between New Zealand datasets and all international OBIS datasets were similar to those of number of records (Figure 8, Figure 9). As many New Zealand datasets are regularly updated, and are planned for upload to OBIS, it is assumed that future calculations of this statistic are likely to require only access of OBIS datasets, making the data extraction process simpler. In the meantime, we opted to include both New Zealand and all other international datasets available on OBIS for the Tier 1 Marine Biodiversity calculations.

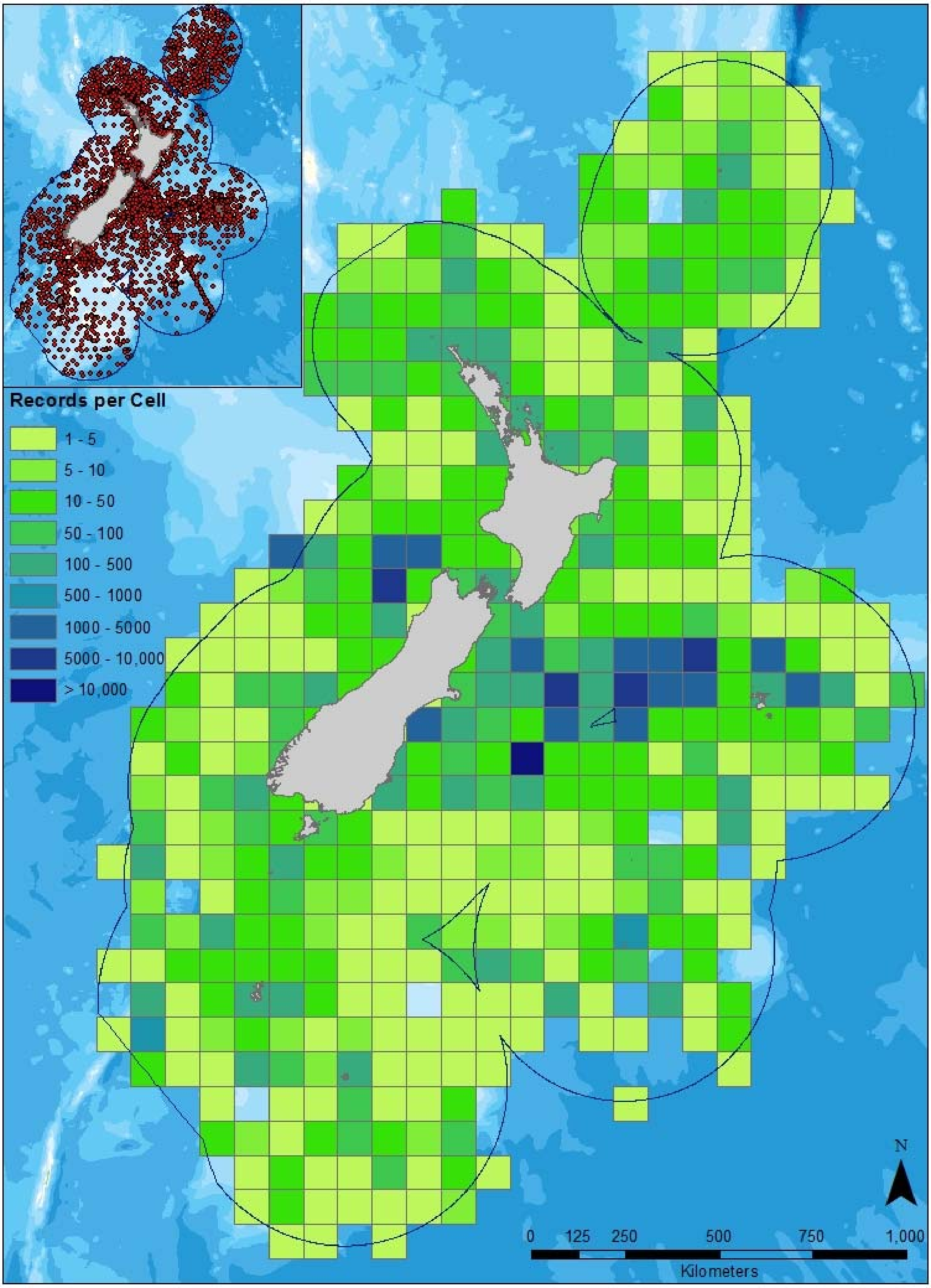


Figure 6: Number of taxonomic records per grid cell from OBIS taxonomic databases (omitting New Zealand records) at grid scale of 100 km × 100 km.

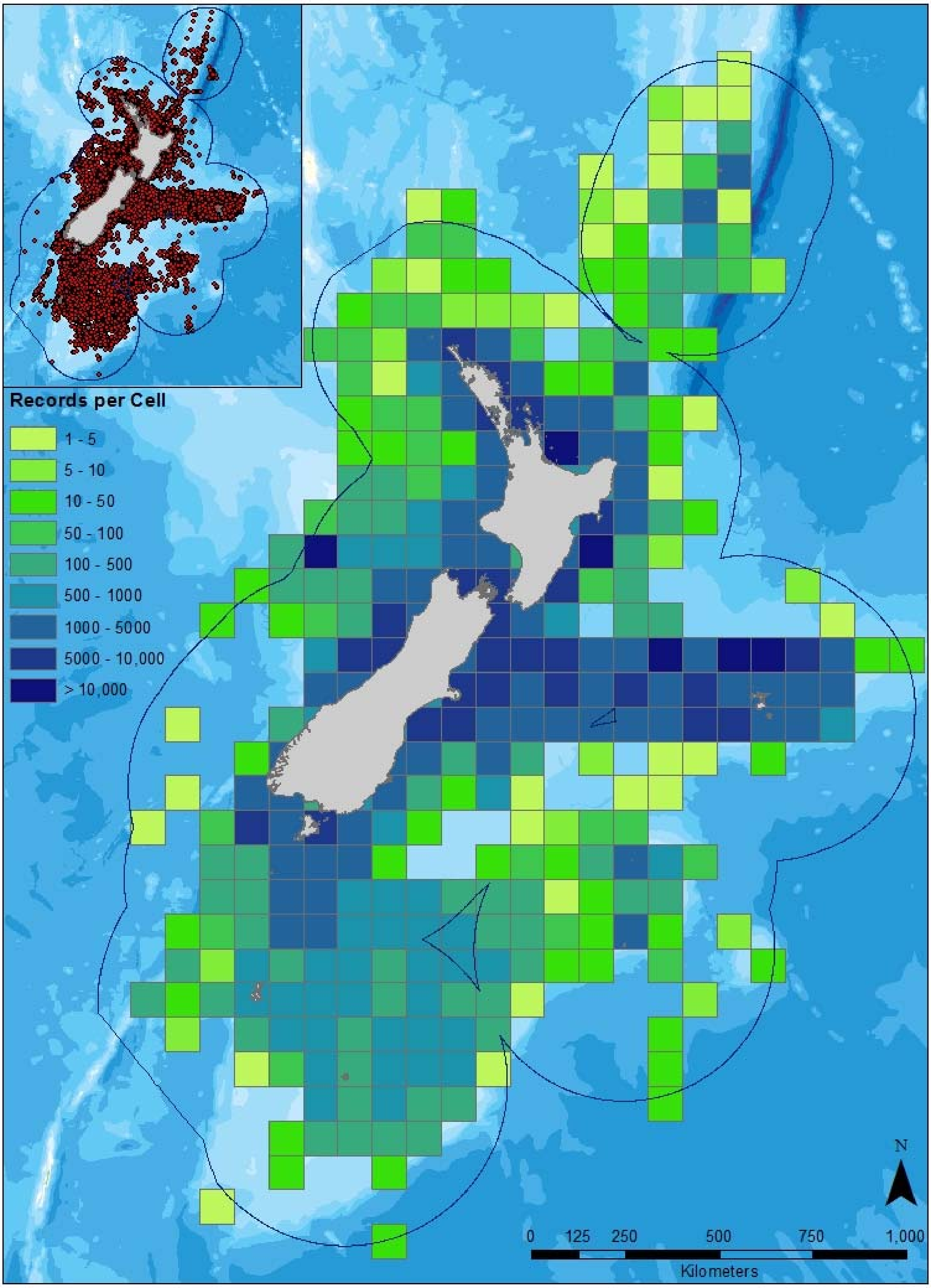


Figure 7: Number of taxonomic records per grid cell from New Zealand taxonomic databases at grid scale of 100 km × 100 km.

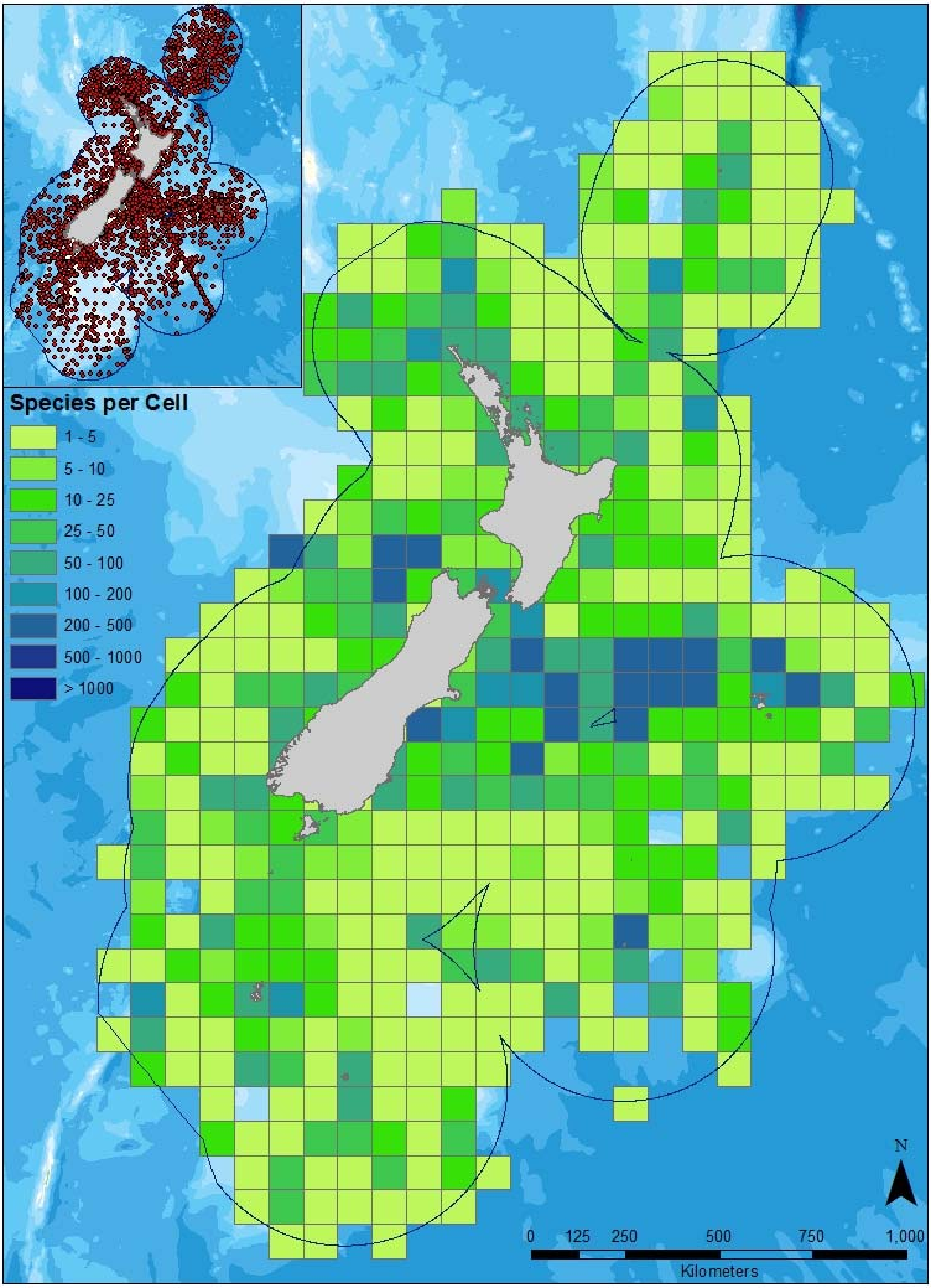


Figure 8: **Species richness (number of species recorded per grid cell) from OBIS taxonomic databases (non-New Zealand records) at grid scale of 100 km × 100 km.**

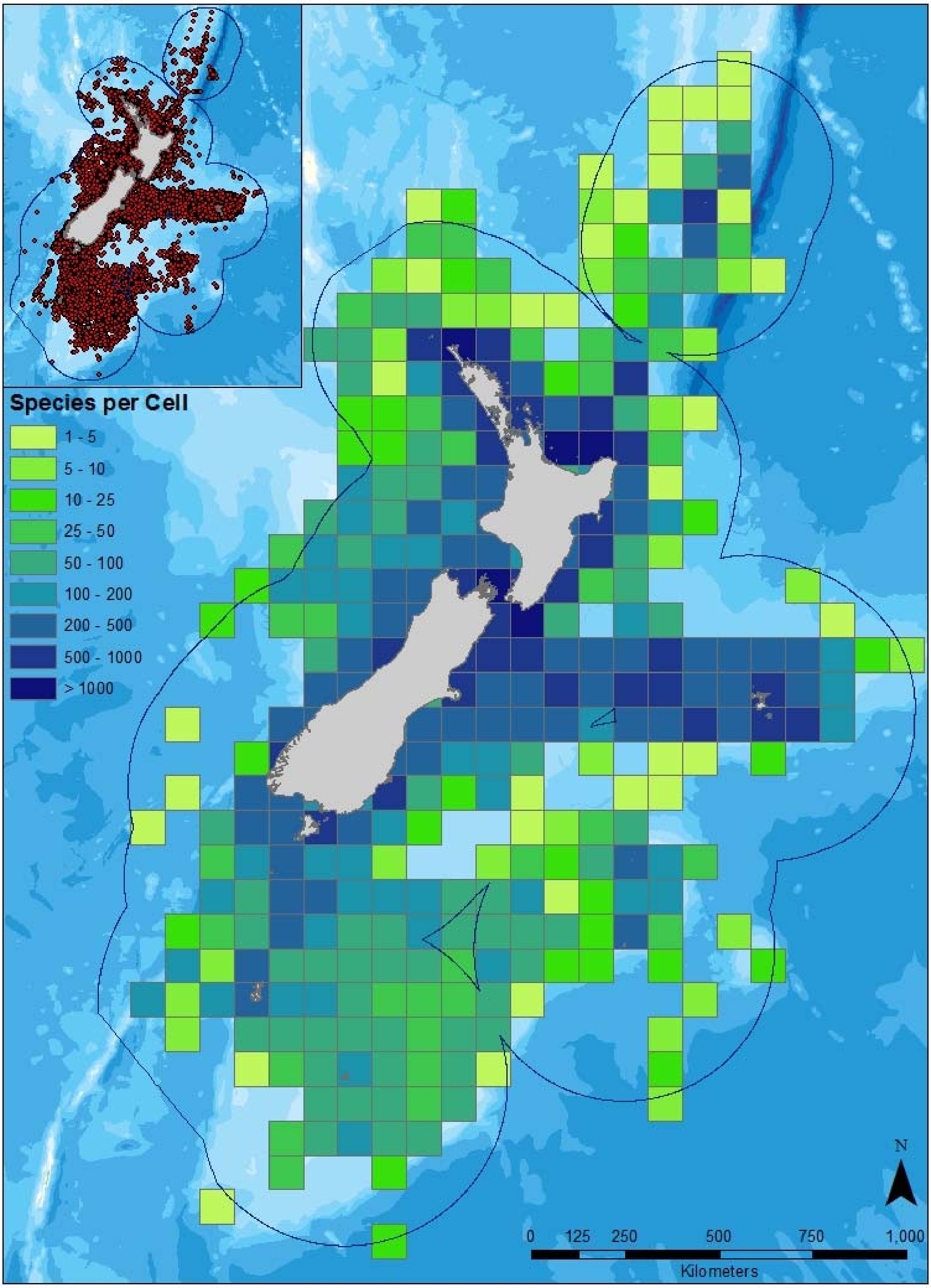


Figure 9: **Species richness (number of species recorded per grid cell) from New Zealand taxonomic databases at grid scale of 100 km × 100 km.**

3.3 Temporal scale of reporting

For a Tier 1 Marine Biodiversity statistic to be useful, it must be able to show changes over the proposed scale of reporting, in this case five yearly. Again, at this stage in our knowledge of marine biodiversity in New Zealand, we are focussed on the process of gathering data as representing New Zealand's commitment to knowledge of the biodiversity of its marine estate. As such, it is expected that for a number of five yearly reports, only increases in our knowledge are likely; i.e., it is impossible to get a decrease in biodiversity using either the number of records or the number of species, as the data available are not designed to determine changes in species abundance or presence/absence, rather they are recording presence only records. With increased focussed monitoring of the marine environmental realm, it should be possible to incorporate changes in species diversity into this statistic at a later stage based on site-specific monitoring schemes.

To investigate the likelihood of a five year reporting period being long enough to show differences in the species richness metric, we investigated the number of records uploaded to OBIS (including some New Zealand datasets) to determine whether sufficient new records are provided over a roughly similar timeframe (eight yearly: 2006–2013) (Table 4). The number of 'new' records varied across taxa, with particular groups (e.g., Bacteria, Plantae) having large number of records uploaded in 2006–2013 (Table 4). This pattern should be expected in the future for other groups (e.g., Bryozoa, Mollusca, Chordata (e.g., fish), when existing New Zealand datasets, including some datasets previously not available on OBIS, are revised and uploaded to OBIS, with large instantaneous increases in the number of records for particular taxonomic groups.

Table 4: Temporal distribution of records in OBIS, comparing all records to more recently uploaded or modified records from 2006–2013.

Taxonomic group	No. records on OBIS Dec 2013	No. records after 2005 on OBIS Dec 2013	% of records uploaded between 2006 and 2013
Kingdom Animalia	**429 771**	**9 120**	2.12
Annelida	7 327	60	0.82
Arthropoda	14 324	940	6.38
Brachiopoda	1 509	2	0.13
Bryozoa	8 121	2	0.02
Cephalorhynca	35	0	0.00
Chaetognatha	600	3	0.50
Chordata	354 109	7 134	2.01
Cnidaria	7 396	278	3.76
Ctenophora	36	0	0.00
Echinodermata	11 170	235	2.10
Echiura	20	0	0.00
Entoprocta	1	0	0.00
Hemichordata	16	0	0.00
Mollusca	23 199	413	1.78
Myxozoa	3	0	0.00
Nematoda	36	0	0.00
Nemertea	24	0	0.00
Phoronida	10	0	0.00
Plathyhelminthes	12	0	0.00
Porifera	1 254	60	4.78
Rotifera	24	0	0.00
Sipuncula	131	0	0.00
Domain Bacteria	**64 812**	**64 811**	99.99
Kingdom Chromista	**31 974**	**11**	0.03
Kingdom Plantae	**776**	**297**	38.27
Kingdom Protozoa	**108**	**0**	0.00

3.4 Taxonomic resolution

The number of records and number of species differ substantially between taxonomic groups, with many smaller phyla having few or no records in the New Zealand EEZ (Table 5, Table 6). Dominant taxonomic groups in terms of number of total records include in order of abundance of species records: 1) Chordata (primarily fishes), 2) Bacteria, 3) Chromista (brown algae and other Chromista), 4) Arthropoda, 5) Mollusca, 6) Echinodermata, 7) Cnidaria, 8) Plantae (primarily red and green algae), 9) Bryozoa, 10) Annelida, 11) Porifera, and 12) Brachiopoda. All other taxonomic groups had fewer than 1000 total records across all datasets (Table 5). In terms of number of species, the proportional representation of taxonomic groups showed different rankings, with Chordata and Bacteria both having the highest numbers of records but ranked much lower in terms of number of species. The ranking for total number of species were: 1) Arthropoda, 2) Mollusca, 3) Cnidaria, 4) Chromista (brown algae and other Chromista), 5) Echinodermata, 6) Porifera, 7) Bryozoa, 8) Chordata (primarily fishes), 9) Annelida, 10) Plantae (primarily red and green algae), 11) Bacteria, and 12) Brachiopoda.

Table 5: Taxonomic distribution of records used in Marine Biodiversity Tier 1 Statistic calculations, comparing contributions of records between broad database sources.

KINGDOM Phylum	Subphylum	Class or Subclass	*Order* Suborder	*Common name*	*No. Records* *OBIS*	*SPECIFY*	*Te Papa*	*Total*
ARCHAEA					0	0	0	0
BACTERIA				Bacteria including cyanobacteria	64 812	0	0	64 812
FUNGI					0	0	0	0
PROTOZOA				Dinoflagellates, foraminifera	108	171	0	279
PLANTAE					776	0	14 842	15 618
Chlorophyta				Green algae	121		2 213	2 334
Rhodophyta				Red algae	647		12 629	13 276
Other				Other flowering plants (e.g., mangrove, seagrass, saltmarsh)	8		0	8
CHROMISTA					31 974	0	4 584	36 558
Ochrophyta				Brown algae	569		4 580	5 149
Other				Other Chromista	31 405		4	31 409
ANIMALIA								
Acanthocephala				Thorny-headed worms	0	0		0
Annelida				Segmented worms	7 327	3 050		10 377
Arthropoda	Crustacea			Crustaceans	14 324	16 997		31 321

KINGDOM			*Order*	*Common name*	*No. Records*			
Phylum	Subphylum	Class or Subclass	Suborder		*OBIS*	*SPECIFY*	*Te Papa*	*Total*
Arthropoda	Non-Crustacea			Marine spiders and mites	401	363		764
Brachiopoda				Lamp shells	1 509	1 819		3 328
Bryozoa				Moss animals, sea mats	8 121	2 729		10 850
Cephalorhyncha					35	0		35
Chaetognatha				Arrow worms	600	12		612
Chordata	Vertebrata	Mammalia	Cetacea	Whales, dolphins, porpoises	1 128			1 128
Chordata	Vertebrata	Mammalia	Carnivora	Sea lions, seals	116			116
Chordata	Vertebrata	Aves		Birds	462			462
Chordata	Vertebrata	Reptilia		Reptiles	1			1
Chordata	Vertebrata	Myxini, Cephala-spidomorphi		Hagfish, lampreys	55			55
Chordata	Vertebrata	Chondrichthyes		Sharks and rays	0			0
Chordata	Vertebrata	Actinopterygii		Ray-finned fish	273 467			273 467
Chordata	Cephalochordata			Lancelets	5	19		24
Chordata	Tunicata			Sea tulips	723	665		1 388
Cnidaria				Sea anemones, corals, jellyfish	7 396	12 800		20 196
Ctenophora				Comb jellies	36	3		39
Cycliophora				Small parasite	0	0		0
Dicyemida				Small parasite	0	0		0
Echinodermata				Sea stars, brittle stars, sea urchins, sea cucumbers	11 170	16 146		27 316
Echiura				Spoon worms	20	59		79
Entoprocta				Goblet worms	1	3		4
Gastrotricha				Meiofauna	0	0		0
Gnathostomulida				Jaw worms	0	0		0
Hemichordata				Acorn worms, pterobranchs	16	14		30
Kinorhyncha				Mud dragons	12	11		23

KINGDOM			*Order*	*Common name*	*No. Records*			
Phylum	Subphylum	Class or Subclass	Suborder		*OBIS*	*SPECIFY*	*Te Papa*	*Total*
Loricifera				Brush heads	0	0		0
Micrognathozoa				Newly described phylum, not yet registered in WoRMS	0	0		0
Mollusca				Molluscs	23 199	6 064		29 263
Myxozoa				Small parasite	3	0		3
Nematoda				Round worms	36	78		114
Nematomorpha				Horsehair worms	0	0		0
Nemertea				Ribbon worms	24	144		168
Orthonectida				Small parasite	0	0		0
Phoronida				Horseshoe worms	10	6		16
Placozoa				Plate animals	0	0		0
Platyhelminthes				Flat worms	12	24		36
Porifera				Sponges	1 254	7 103		8 357
Rotifera				Rotifers	24	0		24
Sipuncula				Peanut worms	131	229		360
Tardigrada				Water bears	0	0		0

Table 6: Taxonomic distribution of species used in Marine Biodiversity Tier 1 Statistic calculations, comparing contributions of species between broad database sources.

KINGDOM Phylum	*Class* Subphylum	Subclass	*Order* Suborder	*Common name*	*No. Species* *OBIS*	*SPECIFY*	*Te Papa*	*Total*
ARCHAEA					0	0	0	0
BACTERIA				Bacteria including cyanobacteria	603	0	0	603
FUNGI					0	0	0	0
PROTOZOA				Dinoflagellates, foraminifera	8	32	0	40
PLANTAE					81	0	798	874
Chlorophyta				Green algae	10		119	127
Rhodophyta				Red algae	66		679	742
Spermatophyta				Other flowering plants (e.g., mangrove, seagrass, saltmarsh)	5			5
CHROMISTA					1 553	0	230	1 646
Ochrophyta				Brown algae	137		230	333
Other				Other Chromista	1 416			1 416
ANIMALIA					7 787	7 577		12 213
Acanthocephala				Thorny-headed worms	0			0
Annelida				Segmented worms	671	411		932
Arthropoda/Crustacea				Crustaceans	1 457	1 866		2 399

KINGDOM	*Class*		*Order*	*Common name*	*No. Species*		
Arthropoda/other				Marine spiders and mites	103	81	125
Brachiopoda				Lamp shells	46	52	80
Bryozoa				Moss animals, sea mats	920	815	1 279
Cephalorhyncha					7	0	7
Chaetognatha				Arrow worms	23	1	23
Chordata	Vertebrata	Mammalia	Cetacea	Whales, dolphins, porpoises	21		21
Chordata	Vertebrata	Mammalia	Carnivora	Sea lions, seals	3		3
Chordata	Vertebrata	Aves		Birds	44		44
Chordata	Vertebrata	Reptilia		Reptiles	1		1
Chordata	Vertebrata	Myxini, Cephala-spidomorphi		Hagfish, lampreys	3		3
Chordata	Vertebrata	Chondrichthyes		Sharks and rays	0		0
Chordata	Vertebrata	Actinopterygii		Ray-finned fish	783		783
Chordata	Cephalochordata			Lancelets	2	4	3
Chordata	Tunicata			Sea tulips	132	111	205
Cnidaria				Sea anemones, corals, jellyfish	967	1 140	1 662
Ctenophora				Comb jellies	2	1	2
Cycliophora				Small parasite	0	0	0
Dicyemida				Small parasite	0	0	0
Echinodermata				Sea stars, brittle stars, sea urchins, sea cucumbers	786	1 071	1 418
Echiura				Spoon worms	8	5	12
Entoprocta				Goblet worms	1	1	1
Gastrotricha				Meiofauna	0	0	0
Gnathostomulida				Jaw worms	0	0	0
Hemichordata				Acorn worms, pterobranchs	4	5	6
Kinorhyncha				Mud dragons	5	5	7
Loricifera				Brush heads	0	0	0

KINGDOM	*Class*	*Order*	*Common name*				*No. Species*
Micrognathozoa			Newly described phylum, not yet registered in WoRMS	0	0		0
Mollusca			Molluscs	1 150	910		1 721
Myxozoa			Small parasite	3	1	0	3
Nematoda			Round worms	9	38		38
Nematomorpha			Horsehair worms	0	0		0
Nemertea			Ribbon worms	12	9		15
Orthonectida			Small parasite	0	0		0
Phoronida			Horseshoe worms	2	3		4
Placozoa			Plate animals	0	0		0
Platyhelminthes			Flat worms	7	7		12
Porifera			Sponges	441	1 039		1 326
Rotifera			Rotifers	4	0		4
Sipuncula			Peanut worms	73	1		74
Tardigrada			Water bears	0	0		0

In determining an appropriate way to report taxonomic differences in species richness that is suitable and informative for the general public, as well as for managers and policy makers, we present three variations of potential taxonomic groupings, varying in resolution of lesser known groups (i.e., Echiura, Sipuncula, Phoronida) and of groups often of particular interest to the public, and for international reporting agreements (i.e., Chordata: seabirds, marine mammals, marine reptiles) (Table 7). Other biodiversity summaries have varied in taxonomic resolution from very low resolution (e.g., Costello et al. 2010) to high resolution (e.g., Supplementary tables available in Gordon et al. 2010). A medium resolution grouping allows presentation of categories that may be of interest to the general public, and important for international reporting statistics, while lumping the large number of smaller invertebrate phyla.

Table 7: Potential groupings for taxonomic representation to be used in Marine Biodiversity Tier 1 Statistic.

Low resolution	Medium resolution	Highest resolution
KINGDOM		
Phylum (Subphylum/Class/SubClass/ Order/SubOrder)		
ARCHAEA	ARCHAEA	ARCHAEA
BACTERIA	BACTERIA	BACTERIA
FUNGI	FUNGI	FUNGI
PROTOZOA	PROTOZOA	PROTOZOA
PLANTAE	PLANTAE	PLANTAE
	Chlorophyta	Chlorophyta
	Rhodophyta	Rhodophyta
	Other	Other
CHROMISTA	CHROMISTA	CHROMISTA
	Ochrophyta	Ochrophyta
	Other	Other
ANIMALIA	ANIMALIA	ANIMALIA
Chordata (Vertebrata, Other)	Chordata (Mammalia)	Chordata (Vertebrata, Mammalia, Cetacea)
		Chordata (Vertebrata, Mammalia, Carnivora)
	Chordata (Vertebrata, Aves)	Chordata (Vertebrata, Aves)
	Chordata (Vertebrata, Reptilia)	Chordata (Vertebrata, Reptilia)
Chordata (Vertebrata, Actinypterigiae)	Chordata (Vertebrata, Other)	Chordata (Vertebrata, Actinypterigiae)
		Chordata (Vertebrata, Chondrichthyes and other fish classes)
Chordata (Other)	Chordata (Other)	Chordata (Cephalochordata)
		Chordata (Tunicata)
Annelida	Annelida	Annelida
Arthropoda	Arthropoda	Arthropoda (Crustacea)
		Arthropoda (Other)
Bryozoa	Bryozoa	Bryozoa
Cnidaria	Cnidaria	Cnidaria
Echinodermata	Echinodermata	Echinodermata
Mollusca	Mollusca	Mollusca
Porifera	Porifera	Porifera
Other invertebrate phyla	Brachiopoda	Brachiopoda
	Platyhelminthes	Platyhelminthes
	Other invertebrate phyla	Acanthocephala
		Cephalorhyncha
		Chaetognatha
		Ctenophora
		Cycliophora
		Dicyemida

Low resolution	Medium resolution	Highest resolution
KINGDOM		
Phylum (Subphylum/Class/SubClass/ Order/SubOrder)		
		Echiura
		Entoprocta
		Gastrotricha
		Gnathostomulida
		Hemichordata
		Kinorhyncha
		Loricifera
		Micrognathozoa
		Myxozoa
		Nematoda
		Nematomorpha
		Nemertea
		Orthonectida
		Phoronida
		Placozoa
		Rotifera
		Sipuncula
		Tardigrada

3.5 Reporting of Records instead of Species

In calculating spatial patterns in species richness, the cost-effectiveness of developing metrics based on species records (i.e., immediately extracted from OBIS, with minimal further manipulation required for geoprocessing to develop spatial patterns for the statistic) can be weighed against the substantial additional effort required to convert species records into spatial patterns of species richness using MGET or other complex geoprocessing algorithms. Spatial patterns in species records and species richness are generally similar, reflecting primarily patterns of sampling and taxonomic effort up to 2013 (Figure 3, Figure 4, Table 8). The similarities between spatial patterns based on records and species richness is consistent across taxa, with plots of ray-finned fishes (Actinypterigiae) (Figure 10), Arthropoda (Figure 11), Annelida (Figure 12), Mollusca (Figure 13), Bryozoa (Figure 14), Chromista (Figure 15), and Plantae (Figure 16) all showing similar relative patterns of high, middle, low and empty cells. This suggests that a statistic using the number of records can provide (at least at this point in our knowledge of marine biodiversity in the New Zealand EEZ) equivalent information to that of the more costly calculation of species richness.

Using records instead of species also side-steps issues of changes in taxonomy. As taxonomy is regularly evolving at levels from species to phyla (i.e., two phyla described in Gordon et al. (2010) have been renamed), species records in OBIS and elsewhere are likely to be modified to reflect updated taxonomy. Other challenges with some data records is that occasionally a taxonomic unit is only identified to higher taxonomic levels, so a true species identity may not yet exist in OBIS or other databases for many records held in national collections. As such, the reports of higher numbers of species found from the combined OBIS/Te Papa/NIWA datasets than reported as the number of described species for a particular taxonomic group is likely to be spurious for some groups (e.g., Porifera) that may be more likely to have species records not defined to genus and species. It is expected that future revisions of this statistic will show more equitability between OBIS-derived measures of species richness to those estimated by Gordon et al. (2010) and available from the New Zealand Inventory of Biodiversity (Gordon (2009), Gordon (2010), Gordon (2012)).

It is still valuable to calculate the number of species described at a national level. OBIS and other datasets do not include (as of 2013) the full complement of species described for the New Zealand EEZ and reported in Gordon et al. (2010) (Table 8). Instead, the number of records available to describe spatial patterns in species richness vary among taxonomic groupings (Table 8). Sampling effort as approximated by the records to species ratio also varies between groups, with some taxonomic groups having substantially higher sampling effort relative to species described (e.g., fishes, with about 348 times as many records as number of fish species). This is in contrast to even some relatively well described groups like Porifera and Bryozoa, for which there are 6 and 8 records per species (on average) respectively (Table 8). Note that the distribution of records is not equivalent across species within a taxonomic group, such that most species groups are represented by a smaller number of common species with more records, and the majority of species are often rarer with only one or two records in the EEZ (e.g., macroalgae, Nelson et al. 2013).

Table 8: **Comparison of biodiversity information compiled by this report with the expert-derived estimates of marine biodiversity across taxonomic groups from Gordon et al. (2010) supplementary information table, revised to reflect updated taxonomy. Note that there are more individual species recorded in OBIS than in Gordon et al. (* in final column); this is likely to be due to records uploaded to OBIS, but not identified to species level.**

	No. described species	No. undescribed	Est'd no. undescribed	No. endemic	No. alien	No. records in study	No. species in study	Records per species	Min. no. species not in OBIS
BACTERIA/ARCHAEA	40	69	190	0	0	64 812	603	107	*
FUNGI	57	0	210	0	0	0	0	0	57
PROTOZOA	1 476	152	2 900	162	4	279	40	7	1 436
PLANTAE									
Chlorophyta	142	0	90	36	0	2 334	127	18	15
Rhodophyta	419	101	150	189	12	13 276	742	18	*
Other	7	0	0	0	0	8	5	2	2
CHROMISTA									
Ochrophyta	734	43	630	55	11	5 149	333	15	401
Other	83	0	25	1	0	31 409	1 416	22	*
ANIMALIA									0
Acanthocephala	24	5	50	1	0	0	0	0	24
Annelida	528	263	1 005	238	32	10 377	932	11	*
Arthropoda/Crustacea	2 166	407	4 930	944	27	31 321	2 399	13	*
Arthropoda/other	147	7	215	61	1	764	125	6	22
Brachiopoda	41	9	17	15	0	3 328	80	42	*
Bryozoa	622	331	295	581	24	10 850	1 279	8	*
Cephalorhyncha (prev. Priapulida)	3	0	4	0	0	35	7	5	*
Chaetognatha	14	0	25	0	0	612	23	27	*
Chordata (Vertebrata/Mammalia/Cetacea)	41	0	0	1	0	1 128	21	54	20
Chordata (Vertebrata/Mammalia/Carnivora)	8	0	0	1	0	116	3	39	5
Chordata (Vertebrata/Aves)	122	2	0	41	0	462	44	11	78
Chordata (Vertebrata/Reptilia)	6	0	0	0	0	1	1	1	5
Chordata (Vertebrata/All fish classes)	1 313	74	762	242	6	273 522	786	348	527
Chordata (Cephalochordata)	1	0	0	1	0	24	3	8	*

	No. described species	No. undescribed	Est'd no. undescribed	No. endemic	No. alien	No. records in study	No. species in study	Records per species	Min. no. species not in OBIS
Chordata (Tunicata)	189	3	195	125	12	1 388	205	7	*
Cnidaria	794	322	630	258	23	20 196	1 662	12	*
Ctenophora	15	4	12	5	0	39	2	20	13
Cycliophora	0	0	0	0	0	0	0	0	0
Dicyemida	5	1	15	6	0	0	0	0	5
Echinodermata	557	66	45	237	0	27 316	1 418	19	*
Echiura	5	2	15	0	0	79	12	7	*
Entoprocta (prev. Kamptozoa)	6	7	30	2	1	4	1	4	5
Gastrotricha	0	5	190	0	0	0	0	0	0
Gnathostomulida	2	10	12	4	0	0	0	0	2
Hemichordata	5	2	4	1	0	30	6	5	*
Kinorhyncha	6	39	30	6	0	23	7	3	*
Loricifera	0	4	10	2	0	0	0	0	0
Micrognathozoa	0	0	1	0	0	0	0	0	0
Mollusca	2 340	1 253	430	2 923	14	29 263	1 721	17	619
Myxozoa	0	0	0	0	0	3	1	3	*
Nematoda	155	52	1 430	25	0	114	47	2	108
Nematomorpha	1	0	0	1	0	0	0	0	1
Nemertea	28	26	350	28	0	168	15	11	13
Orthonectida	0	1	20	1	0	0	0	0	0
Phoronida	3	0	2	0	0	16	4	4	*
Placozoa	0	0	1	0	0	0	0	0	0
Platyhelminthes	229	95	1 810	91	2	36	12	3	217
Porifera	472	963	310	455	7	8 357	1 326	6	*
Rotifera	2	0	95	0	1	24	4	6	*
Sipuncula	26	0	10	2	0	360	74	5	*
Tardigrada	3	2	60	0	0	0	0	0	3
Xenacoelomorpha (prev. Xenoturbellida)	0	0	0	0	0	0	0	0	0

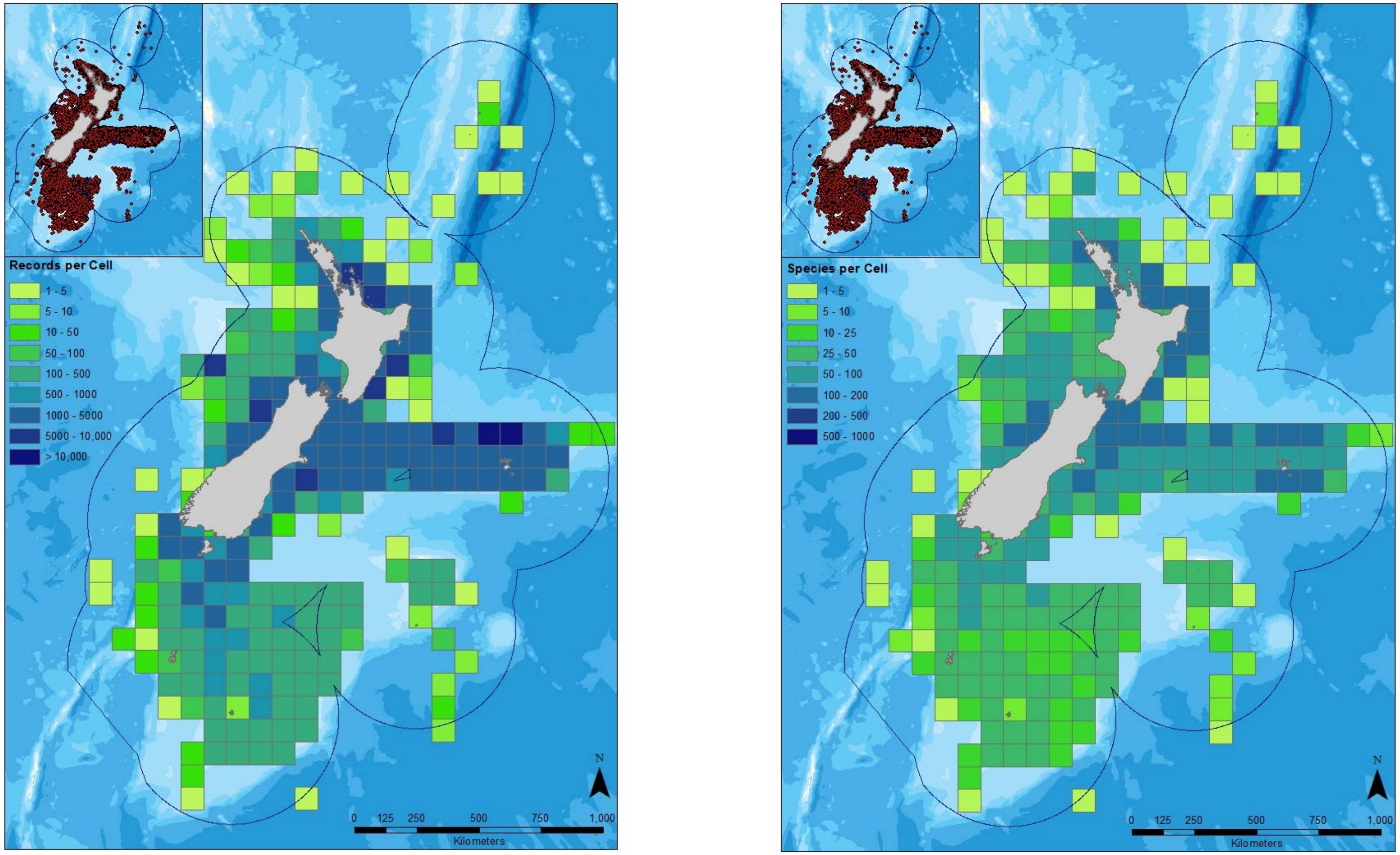


Figure 10: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of Actinypterigiae (bony fish) at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

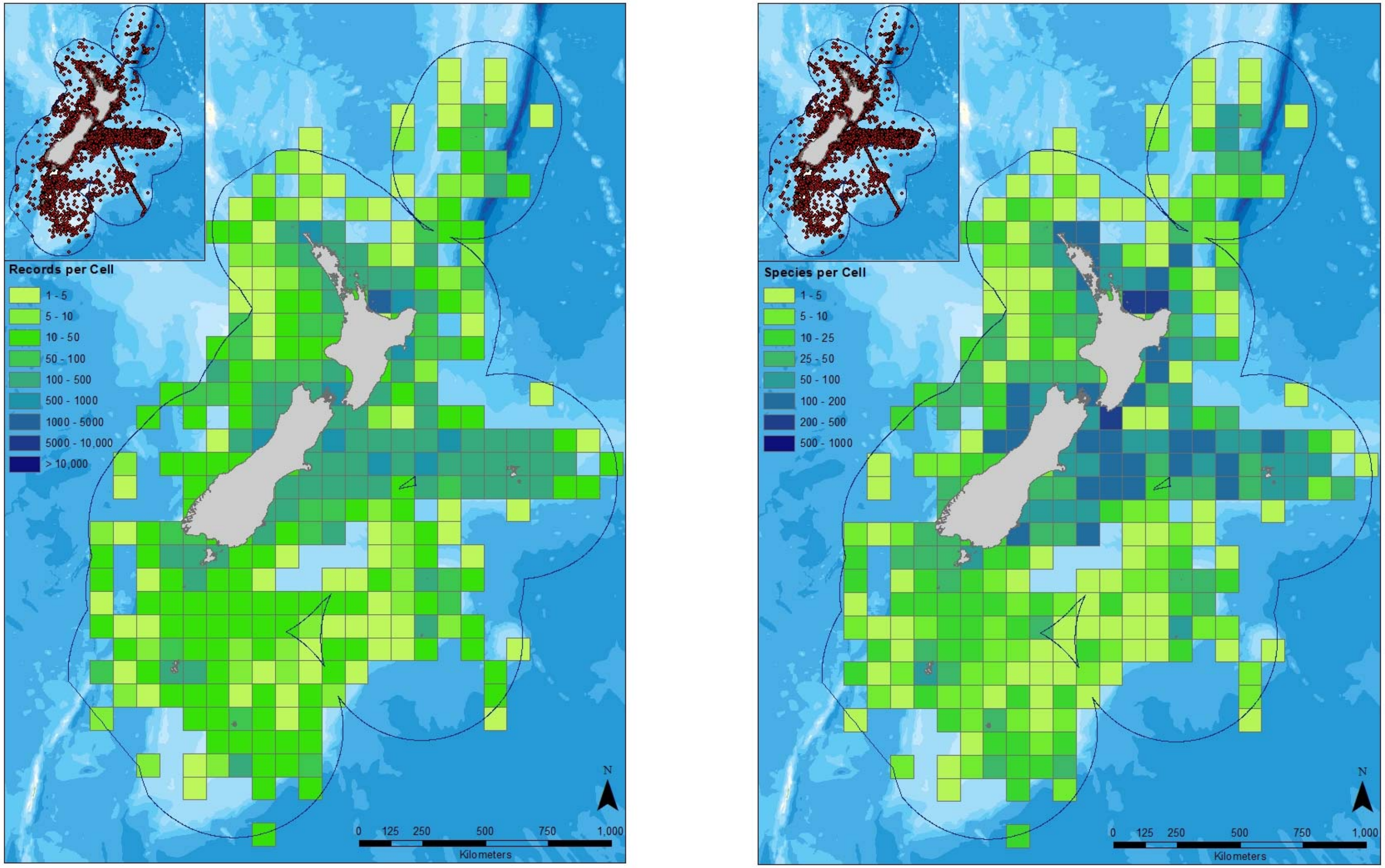


Figure 11: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of Arthropoda (primarily crustaceans) at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

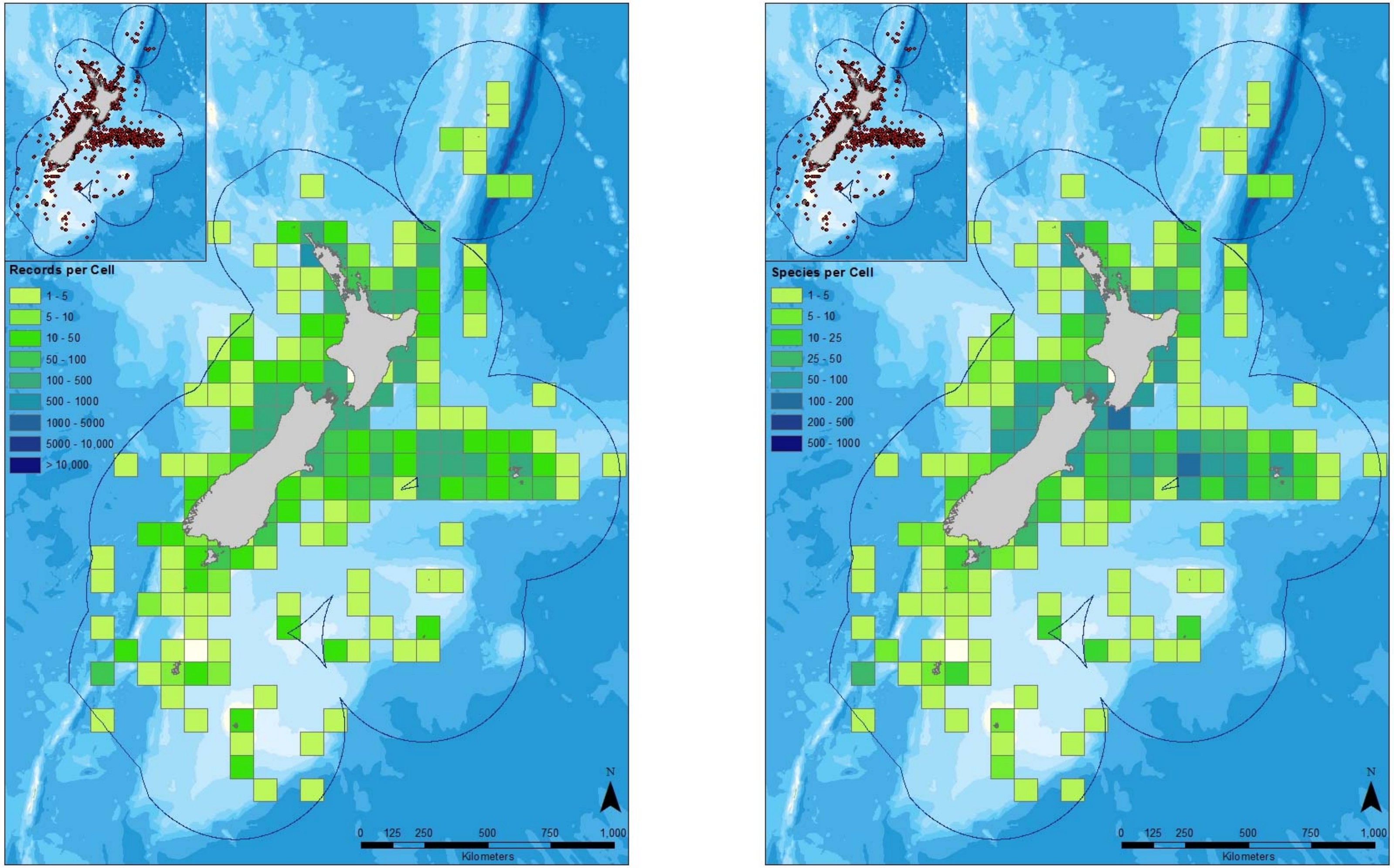


Figure 12: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of Annelida (primarily marine polychaetes) at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

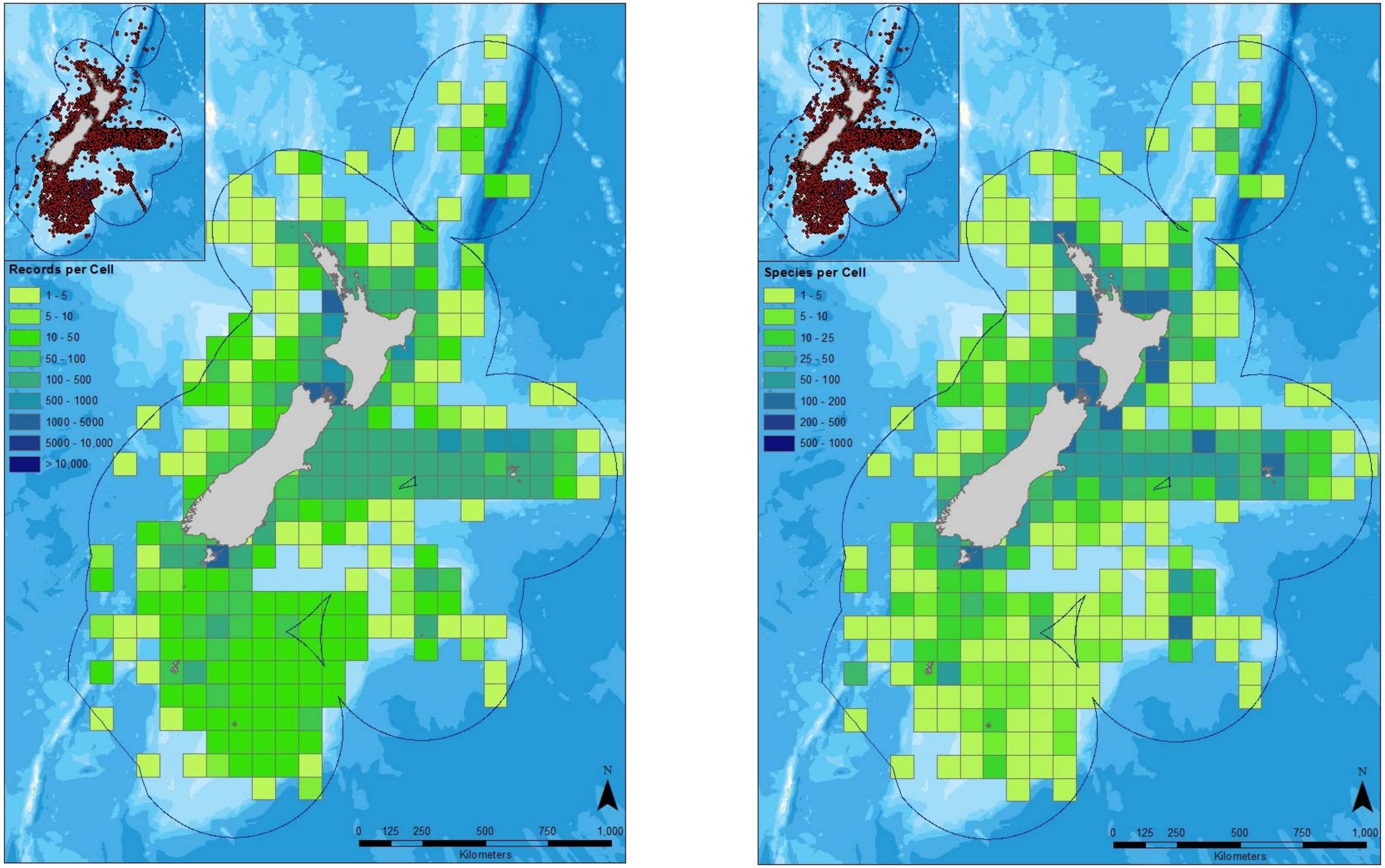


Figure 13: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of Mollusca (gastropods, bivalves, cephalopods) at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

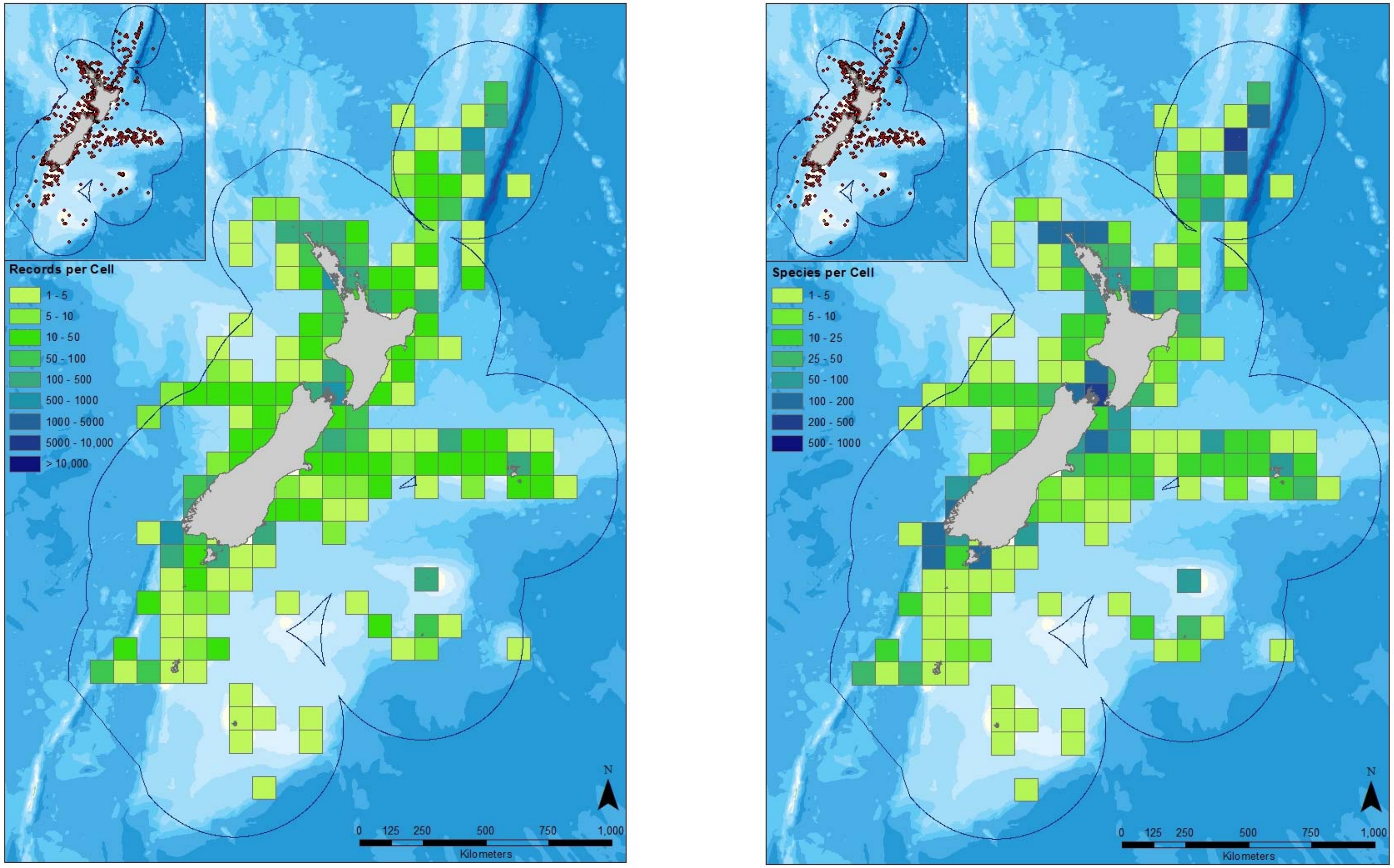


Figure 14: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of Bryozoa at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

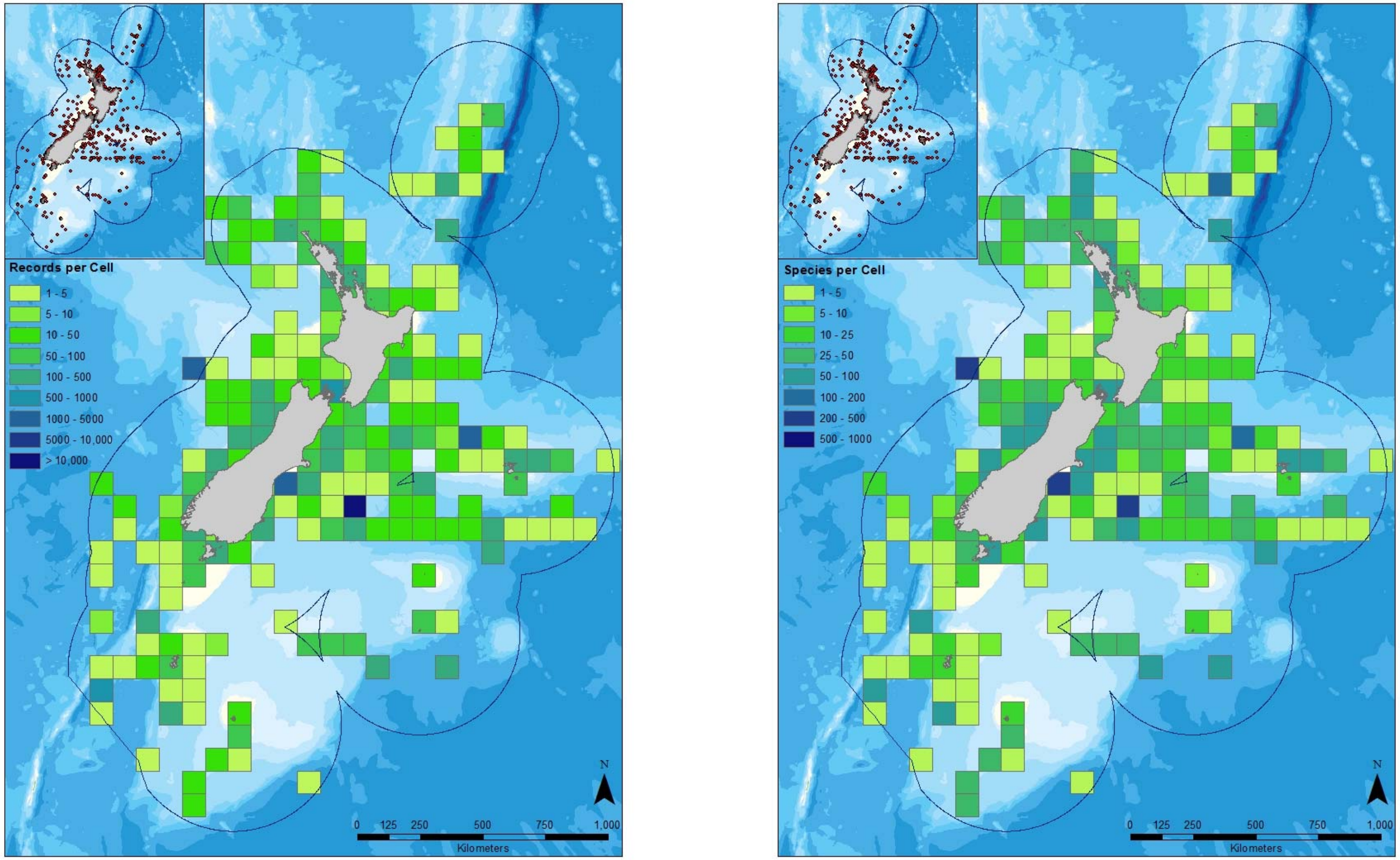


Figure 15: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of marine Chromista at grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

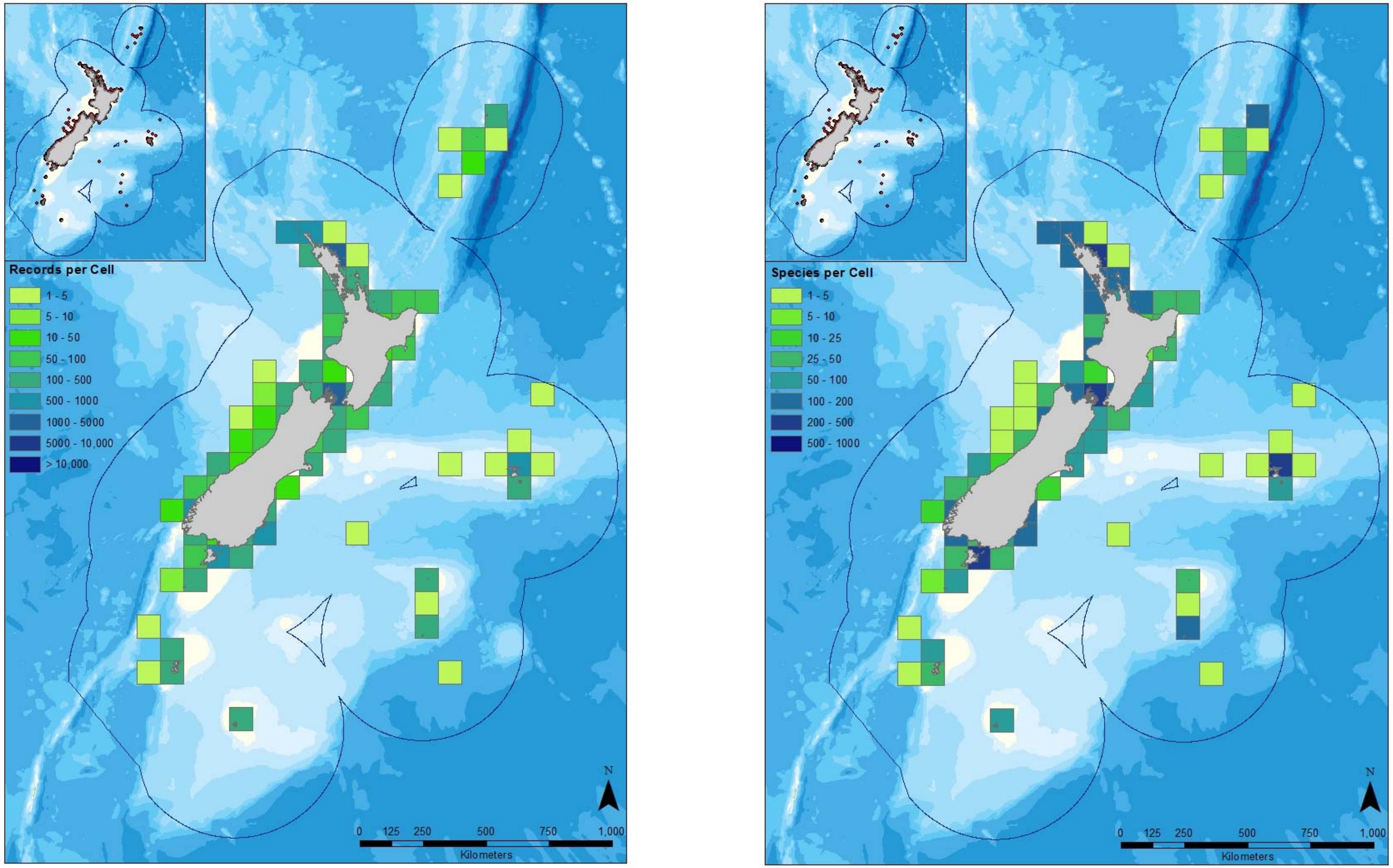


Figure 16: Demonstration of variation in spatial coverage between taxonomic groups. Species richness of marine Plantae at a grid scale of 100 km × 100 km across all datasets. Left: number of records. Right: number of individual species identified.

3.6 Summary recommendations: Species Richness

In summary, reporting on species richness highlights a key factor relating to the development of a Tier 1 Marine Biodiversity Statistic: our knowledge of marine biodiversity is low relative to other developed countries, particularly in the ERMS (Europe) region, where sampling has been undertaken for many more years. As such, any statistic relating to species richness is in reality a State of Knowledge index, as changes in the spatial distribution and the number of taxa will initially represent increases in knowledge, both in terms of increased sampling effort where gaps in spatial sampling coverage are currently evident, and increased knowledge if additional sampling effort is focussed on the many under-represented groups in the marine biodiversity record, particularly invertebrate groups. Moreover, data entering the databases is essentially for taxonomic purposes rather than monitoring and thus does not always include all species found in a sample, i.e., if a species is not reported we do not know whether it is not there. This complicates both qualitative and quantitative estimates of species richness. Finally, as there is no structured or coherent sampling design at present, species richness can only increase; there is no way of determining decreases over time.

As our understanding of marine biodiversity increases, we will be able to better assess hotspots of biodiversity, and the features that they are associated with in the New Zealand EEZ. Similarly, with adequate knowledge of patterns in marine biodiversity, we can better assess changes in species ranges, decreases in abundance of common and rare taxa, and other aspects that may reflect impacts of disturbances and climate change on marine biodiversity. However, it is more likely that changes in marine biodiversity would be better assessed from observed changes in directed monitoring across a number of locations, while the information gleaned from OBIS and other taxonomic datasets would focus primarily on changes in our state of knowledge of marine biodiversity.

From our initial assessment of available data to assess patterns in marine biodiversity, we recommend a cost-effective statistic reporting on species richness should:

- Have a spatial scale of reporting of 100 km × 100 km grid cells.
- Include all datasets uploaded on OBIS. Encourage (and provide funding for, if necessary) data managers to regularly update New Zealand biodiversity datasets and upload them to OBIS, including NIWA datasets, Te Papa and other museum collections, and other national datasets identified in this report. Electronic linkages (currently being implemented) should be restored such that regular updates to OBIS from the South Western Pacific Node occur.
- Use WoRMS as the main source of taxonomic nomenclature, and ensure that electronic linkages between NZOR and WoRMS are restored such that New Zealand based advances in taxonomy are included in the international taxonomic record.
- Have a temporal scale of reporting of five yearly.
- Report number of species in total for the New Zealand EEZ to medium taxonomic resolution such that groups for which the public is familiar (e.g., vertebrates) have higher resolution, and smaller uncommon phyla are combined.
- Report spatial patterns using the number of records extracted from OBIS as a proxy for patterns in species richness based on the number of individual species.
- Use gaps in spatial and taxonomic information to identify priorities for further sampling surveys in poorly studied regions, and funding toward taxonomic training.
- Be considered as reporting on New Zealand’s commitment to advancing the nation’s knowledge of biodiversity, rather than as an estimate of biodiversity *per se*.

4. State of Knowledge Index

As discussed in Section 3, compilation of existing information on marine biodiversity in the New Zealand EEZ suggests that our biggest challenge is that of the poor state of knowledge, both taxonomically and spatially. Gordon et al. (2010) estimated that only 31% of New Zealand’s marine biodiversity has been described, quantifying a total of 17 135 known species, including 4315 collected but as yet undescribed species, and an estimated 17 220 (at minimum) further undescribed species. In terms of our spatial understanding of marine biodiversity, approximately 50% of cells had fewer than 50 biodiversity records, and 38% of cells had 10 or fewer recorded species. As such, much of the increase in the state of knowledge will be revealed through increases in sampling effort in under-studied regions of the EEZ, and efforts to reduce bias in taxonomic sampling and expertise, and in formal taxonomic descriptions of 'known' undescribed species. Plots of temporal (five yearly) subsets of the spatial distribution of new records can demonstrate increases in the state of the spatial knowledge of New Zealand's marine biodiversity.

Other biodiversity reviews have used expert-derived metrics to define the state of knowledge of marine biodiversity. Data reported in Costello et al. (2010) on the state of knowledge of marine biodiversity included metrics based on the number of taxonomic experts, the age and number of identification guides, and the percentage of taxa described, summarised over broad national and international regions. Gordon et al. (2010) reported the metrics as in Costello et al. (2010), and also included the number of collected and as yet, not formally described species (labelled 'known undescribed'), in addition to an estimate of the number of undescribed taxa across phyla that have not yet been collected or described. Outside of major museums and research institutes, it will be potentially difficult in future to track down taxonomic experts and to track identification guides, many of which are developed for amateur field identification by non-taxonomists.

However, the state of knowledge can be most adequately assessed by our knowledge of species biodiversity itself. New species records can be found through reviews of peer-reviewed publications in key taxonomic literature including New Zealand local taxonomic journals, which often include in their title 'New record of…". For most taxa, these new taxonomic records are uploaded to NZOR, with data providers for marine taxa reported on the NZOR website (as at July 2012) to include:

- Marine algae data maintained by Tē Papa
- Digitised checklists from the New Zealand Inventory of Biodiversity, Volumes 1,2,3, Edited by Dennis P. Gordon. (excluding plants and fungi)

State of knowledge is also relevant to the Threatened Species metric, discussed in Section 6. Two categories within the New Zealand Threatened Species Classification ('not assessed' and 'data deficient') refer to taxa for which information has either not been compiled, or is not yet available to determine whether a taxa is or is not threatened.

4.1 Summary recommendations: State of Knowledge

- Report number of newly described species across taxonomic groups.
- Report new species records in geographic context (as for methods for Species Richness, but using a five yearly subset of recent data) as a measure of increased geographic knowledge.
- Use gaps in spatial and taxonomic information to identify priorities for further sampling surveys, and decrease the number of areas that are poorly sampled.
- Use gaps in taxonomic information to identify priority databases to encourage upload to OBIS.

5. Endemic species metric

Costello et al. (2010) reported the number of endemic species across broad taxonomic categories (Plants, Invertebrates, Fish, Other vertebrates) at a national scale. New Zealand's marine species have a high level of endemism, with over 50% of described species reported as endemic to New Zealand's EEZ (Costello et al. 2010, Gordon et al. 2010). While Gordon et al. (2010) provides a starting point for estimates of the proportion of endemic species for higher resolution taxonomic groupings (Table 8), these proportions are unlikely to change in a significant way with new species described, based on the small numbers of new taxa likely to be described on a five yearly basis relative to total species in most taxonomic groups. As such, statistics based on changes in the proportion of endemic species are unlikely to provide useful information on the status of New Zealand's marine biodiversity. However, the static measure of endemicity is, in itself, an important aspect of New Zealand's marine biodiversity, and an important part of the conceptual understanding of the concept of biodiversity, and one of the reasons that New Zealand's marine (and terrestrial) fauna and flora is internationally known as a hotspot of biodiversity.

While unlikely to individually result in a large change in the proportion of endemic species, records of non-indigenous marine species (NIMS) and changes in their distribution are potentially useful indicators of the status of marine biodiversity, as some NIMS are 'invasive exotics', defined as those species that are present outside their natural distribution, and have adverse impacts on native biodiversity. It is assumed that reporting of the impacts of any NIMS taxa (i.e., resulting in decreases in native biodiversity) would be incorporated into the Tier 1 Ecological Integrity statistic, which is proposed for reporting more directly on ecosystem health. However, basic information on the number of NIMS taxa is a useful metric to include to represent changes in biodiversity as related to endemicity of marine fauna and flora.

Should NIMS be included as part of the Tier 1 marine biodiversity statistic, this metric should include data on NIMS sourced from both OBIS and from the national Marine High Risk Site Surveillance (MHRSS) biosecurity database. Data for MHRSS is held and managed by NIWA for the Ministry for Primary Industries (originally MAF Biosecurity); this database includes both transient (e.g., found on vessel hulls) and established NIMS taxa, whereas only established NIMS taxa would be quantified for a Tier 1 marine biodiversity statistic. 177 non-indigenous species were recorded as established in the New Zealand EEZ in 2010 (Gordon et al. 2010). As of December 2013, a total of 334 recorded NIMS taxa had been discovered in New Zealand, including many that were present only on vessel hulls. Within OBIS, records could be extracted for these NIMS taxa on a five yearly basis to determine whether there are changes in the spatial distribution of these taxa. Using BIODS, changes in the number of primary and secondary ports at which a NIMS are recorded could be used as an indicator of whether initiatives to reduce the influx of NIMS via ballast water and vessel hull cleaning initiatives are resulting in a reduction in transport of NIMS. Similarly, changes in the number of NIMS taxa could also be reported using information provided by Ministry for Primary Industries Biosecurity of any new NIMS taxa recorded within the five yearly update period, or any new records on NIMS taxa recorded on NZOR or from the NIWA Marine Invasives Taxonomic Service (MITS).

5.1 Summary recommendations: Endemic species

A statistic reporting on the proportion of endemic species is unlikely to demonstrate substantial change within a five year reporting period, and is thus unlikely to be a useful indicator of changes in marine biodiversity. Rather, the presence and change in status of non-indigenous marine species (NIMS) would be a more useful indicator of changes in marine biodiversity, as some NIMS taxa have negative impacts on native marine biodiversity. If not overlapping the Ecological Integrity Tier 1 statistic or other national reporting programmes, we recommend:

- Report on the relatively static measure of the proportion of endemic species as an important aspect of New Zealand's marine biodiversity.
- Do not report on changes in the proportion of endemic species
- Rather report on
    - Change in spatial distribution of NIMS taxa
    - Changes in number of NIMS taxa recorded in the New Zealand EEZ

6. Threatened species metric

Costello et al. (2010) reported on a ranked summary of the major threats to marine biodiversity at a national scale, rather than on the number or presence of threatened species in the New Zealand EEZ. Here, we discuss a different metric, that of the number of threatened species found in New Zealand, and trends in their status.

The concept of 'threatened species' has evolved out of threat classification systems that aim, in part, to quantify and identify those species most at risk from extinction. Perhaps the most well-known of these systems is the International Union for Conservation of Nature's (IUCN) 'Red List' (see http://www.iucnredlist.org/), which takes a global view of risk from extinction. Species are assessed against a set of quantitative criteria and assigned to one of several threat classifications with increasing risk of extinction, ranging from 'Least Concern' and 'Near Threatened' to the three threatened classifications of 'Vulnerable', 'Endangered' and 'Critically Endangered' and finally two further categories of 'Extinct in the Wild' and 'Extinct'. To date (February 2014), the Red List has assessed over 71 500 taxa, but with a strong bias towards vertebrates (over 37 000 taxa).

In New Zealand, Molloy et al. (2002) developed a threat classification system similar in many respects to the IUCN's Red List, which was later revised by Townsend et al. (2008). Townsend et al. (2008) noted that the New Zealand Threat Classification System (NZTCS) was intended to be complementary to the IUCN's Red List, but to be 'focussed at the national level', providing 'a more sensitive classification for taxa with naturally restricted distributions and small numbers as a result of insular rarity'.

The NZTCS comprises more categories compared to the Red List: taxa are classified as 'Introduced and Naturalised', native taxa are classified as 'Migrant', 'Vagrant' or 'Coloniser' or 'Resident'. Those taxa that are both native and resident are classified as 'Not Evaluated'/'Data Deficient' or 'Evaluated'. 'Evaluated' taxa can be 'Extinct' or 'Not Threatened' at which classification stops. However, 'At Risk' is further broken down to 'Naturally Uncommon', 'Relict', 'Recovering' and 'Declining', 'Threatened' is further broken down to 'Nationally Vulnerable', Nationally Endangered' and 'Nationally Critical', following the diagram below (Figure 17), adapted from Townsend et al. (2008).

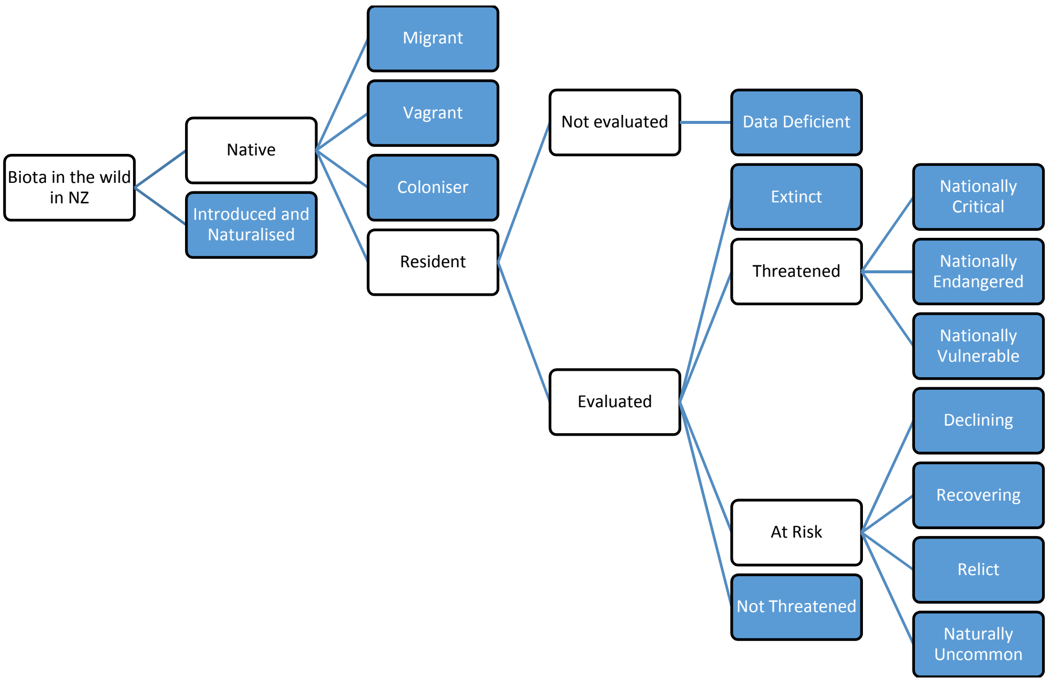


Figure 17: Classification scheme underlying the New Zealand Threat Classification System (NZTCS), adapted from Townsend et al. (2008).

The criteria used to determine which of these categories particular taxa are assigned to can be found in Townsend et al. (2008), but for example, a taxa classified as 'Nationally Critical' would have either:

A. a very small population
   A(1) fewer than 250 mature individuals
   A(2) no more than two sub-populations, no more than 200 mature individuals in the larger sub-population
   A(3) Total area of occupancy no more than 1 ha

Or

B. a small population with a high ongoing or predicted decline
   B(1/1) 250–1000 mature individuals, predicted decline 50–70%
   B(2/1) no more than five sub-populations, no more than 300 mature individuals in the largest sub-population, predicted decline 50–70%
   B(3/1) Total area of occupancy no more than 10 ha, predicted decline 50–70%

Or

C. a population (irrespective of size or number of sub-populations) with a very high ongoing or predicted decline of more than 70%

The NZTCS's long-term aim is to list all extant species by the threat of extinction. Hitchmough (2013) lists 23 groups of taxa that have been reviewed to some extent, additionally noting that algae, freshwater invertebrates and marine fish had not been reviewed. Taxonomic groups are assessed by a panel of experts. It was suggested that each species group be assessed every three years, although regular reporting has been inconsistent both within and between taxonomic groups. Formal inclusion within a five yearly Tier 1 reporting statistic would provide both consistent funding and regularity of reporting across all taxonomic groups.

A second concept 'protected species' is also used in New Zealand, and includes most New Zealand seabirds, marine mammals, and marine reptiles, nine fish including gropers, sharks and rays, and black corals, stony corals, hydrocorals and gorgonians. These are generally taxa for which fishing or other human uses of the environment have the potential to reduce numbers through incidental capture, habitat damage and modification, or other direct or indirect effects. The list of protected marine species in New Zealand includes taxa that have been assessed as threatened within the NZTCS, but also many species that are not currently threatened. Protected species are managed through the Fisheries Act 1996 (sections 8, 9, and 15), the Marine Mammals Protection Act (1978) and the Wildlife Act (1953). A list of protected marine species is provided in Schedule 7A of the Wildlife Act, with the most recent amendment to this list being in 2010. While outside the scope of a national reporting statistic, this investigation highlights this disconnection between threatened and protected taxa; better coordination of these 'conceptual' listings is warranted for marine species, with the suggestion that regular reporting cycles of Threatened species would lead to amendments to the Wildlife Act (1953) to add any new threatened species such that they receive the protections provided in this legislation.

In the marine realm, there have been reviews of marine mammals in 2009 (Baker et al. 2010), seabirds as part of the birds reviews in 2008 (Miskelly et al. 2008) and 2012 (Robertson et al. 2013), marine reptiles as part of the reptiles reviews in 2009 (Hitchmough et al. 2010) and 2012 (Hitchmough et al. 2013) and marine invertebrates in 2009 (Freeman et al. 2010) (Table 9). All New Zealand marine mammals, seabirds and reptiles have been assessed (Baker et al. 2010, Hitchmough et al. 2013, Robertson et al. 2013), but only 295 marine invertebrates were reviewed by Freeman et al. (2010) (Table 9).

Although the coverage of marine taxa is currently very patchy, and clearly biased towards the relatively large, conspicuous taxa, the NZTCS is both robust and valuable in terms of charting the long-term trends in conservation status of individual taxa and groups of taxa and also in terms of identifying taxa requiring specific conservation management. Taken across the entire marine realm, there are currently insufficient assessments across many taxonomic groups to justify the use of 'number of threatened species' as a Tier 1 statistic. The challenge to assess every marine species, as part of assessing all extant New Zealand taxa, is truly daunting, not least because there is simply insufficient reliable information on which to base an assessment for the vast majority of marine species – such taxa would be classified as ‘Data Deficient’, which would constitute the dominant classification. Additionally, it is difficult to see how the majority of marine taxa could be assessed in a timeframe of less than many decades without a substantial shift in resource allocation that would enable population sizes, trends and distributions to be determined. However, theoretically, and assuming that more taxonomic groups will be comprehensively assessed in the future, the NZTCS and its concept of a ‘threatened species’ could become a meaningful Tier 1 statistic for marine biodiversity, perhaps restricting its use to well-defined species groups afforded comprehensive or near-comprehensive coverage.

It is also worth noting that for the majority of marine taxa assessed to date, which tend to be generally long-lived and slowly-reproducing species, conservation status represents a relatively conservative statistic – the transition from one threat category to a lower threat category (i.e. an improvement in the conservation status of a particular taxa, perhaps resulting in a reduction in the number of ‘threatened species’ within a taxonomic group) would be likely to take many years, perhaps even a few decades. For such species the use of the number of threatened species as a useful Tier 1 statistic would only become valuable over similarly long timeframes.

6.1 Threatened species summary statistic

We recommend for the threatened species metric, that the number of threatened taxa in each threat category (both NZTCS and IUCN) is summarised for broad taxonomic groups (Marine mammals, marine reptiles, seabirds, shorebirds, marine fish, marine invertebrates, marine plants), including the proportion of each taxonomic group that have been assessed and the proportion of data deficient taxa (Table 9).

Five yearly reporting on this statistic should further include reporting on:

- change in threat categories across taxonomic groups
- change in number of taxa evaluated
- change in number described as data deficient

Table 9: Number of threatened marine taxa, based on the New Zealand Threat Classification System.

Taxonomic group	Proportion or number assessed	Extinct	Data deficient	Nationally critical	Nationally endangered	Nationally vulnerable	Declining	Recovering	Relict	Naturally uncommon
Marine mammals	100% (63)		13	5	3					
Marine reptiles	100% (7)									
Seabirds	100% (145)	2		10	7	10	9	3	13	24
Shorebirds	100% (126)	13	1	7	3	6	4	3		4
Fish	218		37				2			52
Invertebrates	2.7% (307)		12	10	2	21	8			243
Algae	61		23	1						37

Taxonomic group	Migrant	Vagrant	Coloniser	Not threatened	Introduced and naturalised	IUCN Combined listings	IUCN Vulnerable	IUCN Endangered	IUCN Critically Endangered
Marine mammals	6	20		9		7	2	5	
Marine reptiles	2	5				5	1	2	2
Seabirds	16	40	4	7		15	10 (9 Vagrant, 1 Migrant)	5 (5 Vagrant)	
Shorebirds	7	65	2	10	1	1	1 (Vagrant)		
Fish	10	4		113		13			
Invertebrates				11					
Algae						2			

7. DISCUSSION

This preliminary investigation of marine biodiversity in New Zealand allows evaluation primarily of our current state of knowledge of marine biodiversity. While more than 600 000 biodiversity records were available for this analysis, it points out the bias in spatial coverage of our sampling of the marine environment, with sampling coverage focussed on coastal areas, and areas of particular interest for resource extraction (e.g., the Chatham Rise). This lack of information is in itself of interest for a publicly available statistic on New Zealand's marine biodiversity, in that it shows the public how much more there is to learn about our nation's biodiversity. Other aspects of New Zealand's biodiversity, such as high rates of endemism, though unlikely to change, are of interest to the general public in demonstrating why international experts consistently rank New Zealand's waters as a hotspot for marine biodiversity.

Statistical reporting on marine biodiversity at this early stage in the knowledge of our biodiversity can be used to prioritise areas for which we have poor information on biodiversity. In addition, some taxonomic groups are poorly covered in the biodiversity records in New Zealand, and demonstration of this bias in spatial coverage can also be used to prioritise taxonomic expertise and training in areas for which there are gaps in New Zealand's taxonomic expertise.

Aspects of biodiversity that report on changes, both increases in non-indigenous marine species, and decreases (or increases) in abundance of particular taxa that result in change in threatened species classifications are also important metrics both for public consumption, and for international reporting. Elevation of these metrics to international reporting statistics will put higher priority on generation of this information, and for integration of different New Zealand databases. Public availability of government-funded datasets is mandated, and Tier 1 reporting statistics can provide guidance on data format, accessibility, and quality control.

8. KEYPOINTS FOR POLICYMAKERS

In general, Tier 1 statistics should be of interest to the general public, but also serve both an inward looking role for regional and national decision making, and an outward role for international reporting, and maintaining New Zealand's reputation as a biodiverse and clean and green nation. Most New Zealand citizens would be surprised to find out that New Zealand is the only OECD country that lacks regular national environmental reporting, and the development of a marine biodiversity Tier 1 National Reporting statistics is one step toward providing consistent, transparent reporting on our environment. From a public perspective, a Tier 1 Statistics also has the ability to assist the general public in understanding 'what is marine biodiversity' as well as why New Zealand's marine biodiversity is internationally recognised for its high diversity and endemicity.

Key management implications to support long-term cost-efficient generation of this statistic are in improved resourcing of New Zealand biodiversity databases, and better integration across all New Zealand databases and data management portals within which they are stored and accessed. For some metrics (e.g., threatened taxa), the change to a regular reporting schedule and synchronised reporting across different taxonomic groups will result in improved consistency among reporting standards and higher prioritisation of tasks to identify and report on threatened species trends. Required for international reporting, this will also contribute to New Zealand's environmental reputation, by resulting in fewer taxa which are labelled as either 'not assessed' or 'data deficient'.

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11. APPENDICES

List of datasets held within the OBIS South Western Pacific Node (http://iobis.org). Note that other international datasets have records within the New Zealand EEZ.

Dataset name	**International Polar Year and Census of Antarctic Marine Life subset (South Western Pacific OBIS)**
Original Data Provider	NIWA
Contact	Kevin Mackay (k.mackay@niwa.co.nz)
Abstract	Biological data from the IPY-CAML voyage (TAN0802) by the R/V Tangaroa. The TAN0802 voyage departed from Wellington, New Zealand on Jan 26th 2008 and returned to Wellington, New Zealand, on Mar 21st 2008. The survey was concentrated mainly on the Ross Sea and thee waters around Scott and the Balleny Islands. Biological data was collected using a variety of gear, including: bottom trawls, beam trawls, epibenthic sleds, Van Veen grabs, and MOCNESS tows.
Geographic coverage	Latitude -76.833 to -66.698; Longitude -179.96 to 179.989
Temporal coverage	2004 to 2008
#records	7,219
#taxa	1,285
Dataset name	**Modern foraminifera in the New Zealand EEZ**
Original Data Provider	NIWA
Contact	Kevin Mackay (kevin.mackay@niwa.co.nz)
Abstract	Biodiversity data of the modern foraminifera in the New Zealand EEZ sourced from Dr Bruce Hayward at Geomarine Research. These data come from two projects: (1) modern deep-sea (100-5000 m water depth) foraminifera; and (2) a 7 year project (1991-1998) on the biodiversity and ecological distribution of modern brackish and shallow-water (0-100 m) foraminifera around New Zealand.
Geographic coverage	Latitude -61.767 to -29.4; Longitude -178.818 to 179.996
Temporal coverage	Could not be determined
#records	16,986
#taxa	553
Dataset name	NIWA plankton
Original Data Provider	NIWA
Contact	Kevin Mackay (kevin.mackay@niwa.co.nz)
Abstract	Plankton (mainly zooplankton) observation data held at NIWA
Geographic coverage	Latitude -46.273 to -39.12; Longitude 169.2 to 179.168
Temporal coverage	1976 to 1993
#records	4,624
#taxa	221
Dataset name	**New Zealand Coralline Algae**
Citation	Farr, T.; Broom, J.; Hart, D.; Neill, K.; Nelson, W. (2009). Common coralline algae of northern New Zealand: an identification guide. NIWA Information Series No. 70.
Original Data Provider	NIWA
Contact	Kevin Mackay (k.mackay@niwa.co.nz)
Abstract	Occurrence of New Zealand's non-geniculate coralline flora. This dataset is based on two identification guides published by NIWA and funded through the Ministry of Fisheries Biodiversity Programme in order to make information accessible to marine scientists and resource managers and to improve understanding of these algae.
Geographic coverage	Latitude -52.55 to -34.418; Longitude 169.183 to 178.753
Temporal coverage	1916 to 2007
#records	947

#taxa	34
Dataset name	**South Western Pacific Regional OBIS Data All Sea Bio Subset (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Contact	Steve Massey (s.massey@niwa.co.nz)
Abstract	This is the All Sea Bio Subset of the Full OBIS Provider for NIWA. For the Full dataset please refer to obismaster provider
Geographic coverage	Latitude -82.375 to 55.85; Longitude -180 to 180
Temporal coverage	1897 to 2005
#records	41,925
#taxa	3,488
Dataset name	**South Western Pacific Regional OBIS Data Asteroid Subset (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Contact	Steve Massey (s.massey@niwa.co.nz)
Abstract	This is the Asteroid Subset of the Full OBIS Provider for NIWA. For the Full dataset please refer to obismaster provider
Geographic coverage	Latitude -55.01 to -25.22; Longitude -179.99 to 180
Temporal coverage	1956 to 2003
#records	2,294
#taxa	145
Dataset name	**South Western Pacific Regional OBIS Data Bio Ross Subset (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Contact	Steve Massey (s.massey@niwa.co.nz)
Abstract	This is the Ross Bio Subset of the Full OBIS Provider for NIWA. For the Full dataset please refer to obismaster provider
Geographic coverage	Latitude -72.343 to -65.408; Longitude 160.887 to 173.32
Temporal coverage	2004 to 2004
#records	1,166
#taxa	343
Dataset name	**South Western Pacific Regional OBIS Data Bryozoan Subset (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Contact	Steve Massey (s.massey@niwa.co.nz)
Abstract	This is the Bryozoan Subset of the Full OBIS Provider for NIWA.
Geographic coverage	Latitude -53 to 33.767; Longitude -179.532 to 179.668
Temporal coverage	1874 to 2003
#records	6,348
Dataset name	**South Western Pacific Regional OBIS Data Habitat-forming Cold Water Corals Subset (South Western Pacific OBIS)**
Citation	Tracey, D.M, Rowden, A.A., Mackay, K.A., and Compton, T. 2011. Habitat-forming cold-water corals show affinity for seamounts in the New Zealand region. Marine Ecology Progress Series Vol. 430: 1-22
Original Data Provider	South Western Pacific OBIS
Contact	Kevin Mackay (k.mackay@niwa.co.nz)
Abstract	This is the Habitat-forming Cold Water Corals Subset of the Full OBIS Provider for NIWA. It contains field (observational) data from research surveys and fishing industry trawls conducted in waters around New Zealand.
Geographic coverage	Latitude -56.317 to -26.715; Longitude -179.991 to 180

Temporal coverage	1954 to 2009
#records	631
#taxa	5
Dataset name	**South Western Pacific Regional OBIS Data Specify Subset (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Abstract	This is the Specify Subset of the Full OBIS Provider for NIWA.
Geographic coverage	Latitude -83.5 to 52.033; Longitude -180.808 to 180
Temporal coverage	1900 to 2006
#records	14,023
#taxa	2,371
Dataset name	**South Western Pacific Regional OBIS Data provider for the NIWA Marine Biodata Information System (South Western Pacific OBIS)**
Original Data Provider	South Western Pacific OBIS
Contact	Steve Massey (s.massey@niwa.co.nz)
Abstract	This is the cut down provider for the NZOBIS provider. As at November 2005, this is a work in progress - data is being compiled and added to the NIWA Marine Biodiversity Information System (MBIS - a data warehouse). The data will cover an area from Antarctica to Fiji. Data so far available are primarily the results of a series of research trawl surveys carried out as part of New Zealand's Ministry of Fisheries data collection to support fisheries management within the NZ Exclusive Economic Zone (EEZ), plus data from several decades of marine invertebrate research sampling in the NZ Exclusive Economic Zone.
Geographic coverage	Latitude -54.185 to 0.041; Longitude -180.95 to 179.999
Temporal coverage	1961 to 2005
#records	377,927
#taxa	437
Dataset name	**Xanthichthys greenei, a new species of triggerfish (Balistidae) from the Line Islands**
Citation	Pyle R, Earle J (2013) Xanthichthys greenei, a new species of triggerfish (Balistidae) from the Line Islands. Biodiversity Data Journal 1: e994. DOI: 10.3897/BDJ.1.e994
Original Data Provider	NIWA
Contact	Kevin Mackay (k.mackay@niwa.co.nz)
Abstract	Xanthichthys greenei n. sp. is described from six specimens, 97-154 mm standard length (SL) collected from mesophotic coral ecosystems (90-100 m) at Kiritimati (Christmas Island), Line Islands, part of the Republic of Kiribati in the Central Pacific. Of the six species of Xanthichthys, it is most similar to the Atlantic X. ringens and the Indo-West Pacific X. lineopunctatus, sharing with these species the character of three pigmented cheek grooves. It is distinctive in its low body scale row count (33-35, other Xanthichthys species with 39 or more), small size (maximum SL 154 mm, other species over 225 mm), and color pattern of scattered dark spots sub-dorsally and no other spots or lines on body.
Geographic coverage	Latitude 1.888 to 2.016; Longitude -157.555 to -157.486
Temporal coverage	2005 to 2005
#records	5
#taxa	1